Ionizing Radiation Test Report for FCF Hardware tested March 2003 (and September 2003 and March 2004)

Fluids and Combustion Facility (FCF)

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PREFACE

Under the Microgravity Research, Development, and Operations Contract (MRDOC), the National Aeronautics and Space Administration (NASA) is developing a modular, multi-user experimentation facility for conducting fluid physics and combustion science experiments in the microgravity environment of the International Space Station (ISS). This facility, called the Fluids and Combustion Facility (FCF), consists of two test platforms: the Fluids Integrated Rack (FIR), and the Combustion Integrated Rack (CIR). Also included in MRDOC are the required support efforts for Mission Integration and Operations, consisting of the Telescience Support Center (TSC) and Mission Integration and Planning (MIP).

This document will detail the results of ionizing radiation testing for FCF hardware that was tested in March 2003, September 2003, and March 2004.

SIGNATURE PAGE

IONIZING RADIATION TEST REPORT FOR FCF HARDWARE TESTED MARCH 2003 (AND SEPTEMBER 2003 AND MARCH 2004) FOR THE FLUIDS AND COMBUSTION FACILITY (FCF)

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REVISION PAGE

IONIZING RADIATION TEST REPORT FOR FCF HARDWARE TESTED MARCH 2003 (AND SEPTEMBER 2003 AND MARCH 2004) FOR THE

Revision	Date	Description of Change or ECOs Incorporated	Contractor Verification and Date	NASA Verification and Date
Final	04/17/03	Initial release of test results for FCF hardware tested in March 2003 and September 2003	12/15/03	12/23/03
Rev. A	04/01/04	Incorporate FCF-ECO-0886	Review	Review

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1.0 INTRODUCTION

1.1 Purpose

The purpose of this report is to document the results of the ionizing radiation tests on the following electronic hardware as part of the Fluids and Combustion Facility (FCF). The purpose of the test was to verify the functionality and determine a representative Mean Time Between Failures (MTBF) for various failure modes of the hardware when exposed to a 10 year equivalent dose of ionizing radiation as will be present within the US Lab module of the International Space Station (ISS). Results from this test will be used to provide a go/no-go condition on the engineering design of the FCF or drive changes to our current spares philosophy to support meeting the FCF Operational Availability Requirement of 83%.

The list of hardware that was tested in March 2003, and follow-on testing in September 2003, and follow-on testing in March 2004 is as follows:

I/OP & FCU DY-4 SVME-179-1440 Single Board Computer. See Figure 1.

I/OP DY-4 Dual Channel 1553B PMC-601 Board. See Figure 1.

FSAP & IPSU PEP CP302 Single Board Computer. See Figure 2.

IPSU Bittware Quad 21160 Sharc DSP Board. See Figure 3.

Multiple Package Phytec mini-MODUL-515 CAN Module. See Figure 4.

FOMA Custom Designed Valve Timers. See Figure 5.

IPSU Bittware Quad HS3U “Space” DSP Board (IPSU) (prototypes). See Figure 6.

IPSU VMIC VMIPC-5790 Ultra 160 SCSI Controller. See figure 7.

1.2 Scope

These test results are to be considered one set of results in a series of test results culminating in a final quality assurance/acceptance test of the flight unit hardware involved in ionizing radiation testing.

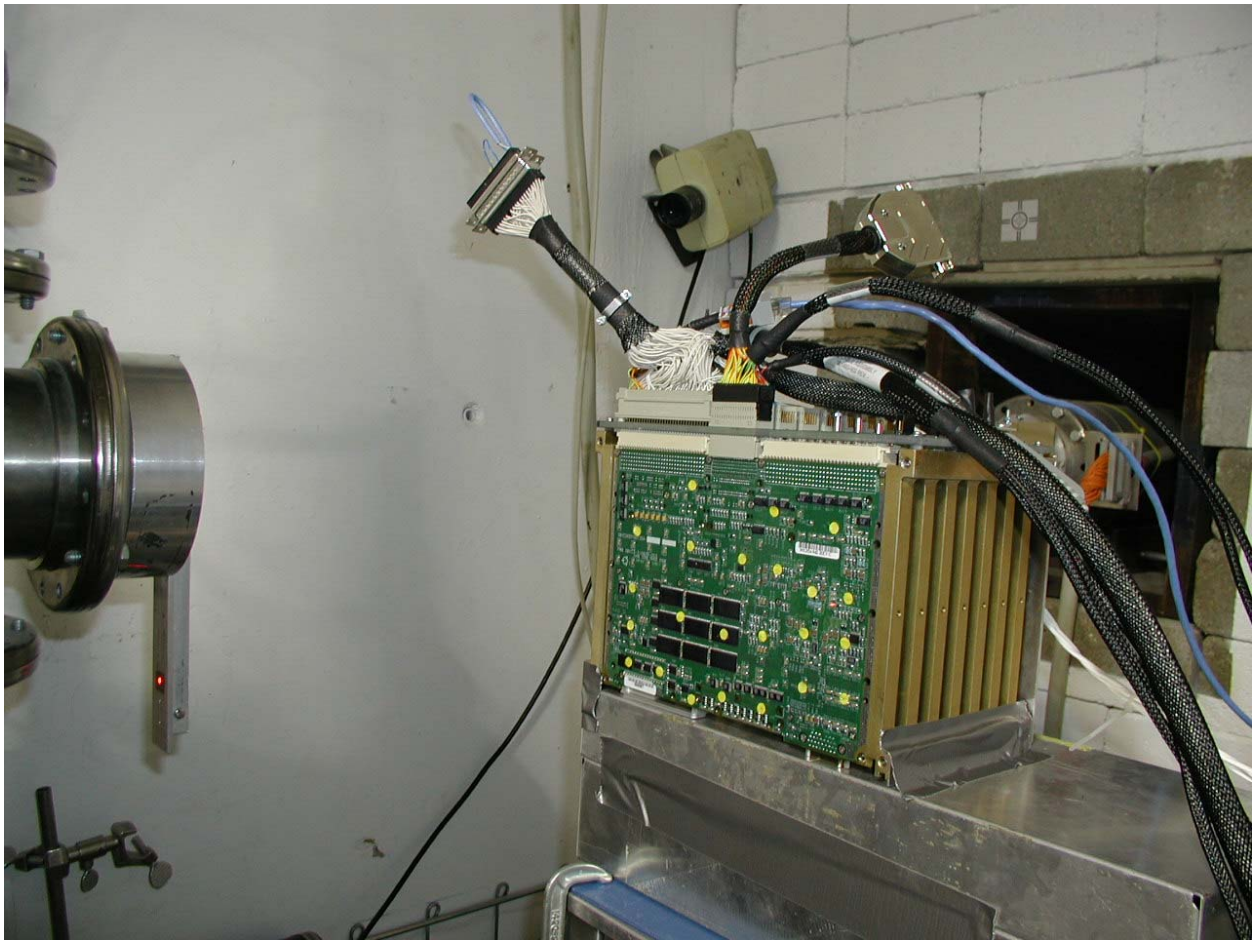

FIGURE 1. DY-4 SVME179-1440 Single Board Computer and DY-4 Dual Channel 1553B PMC601 Board (tested simultaneously)

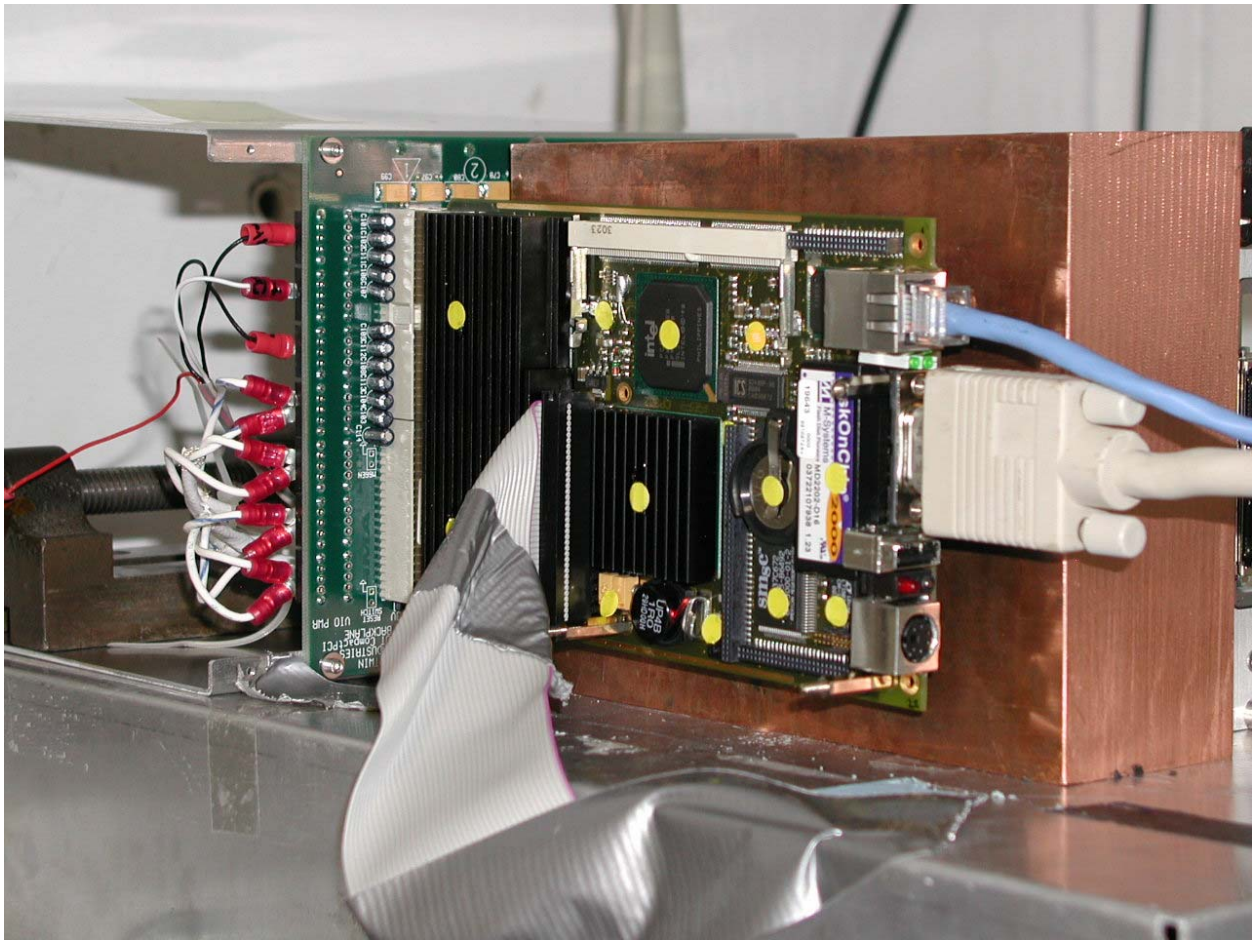

FIGURE 2. PEP CP302 Single Board Computer

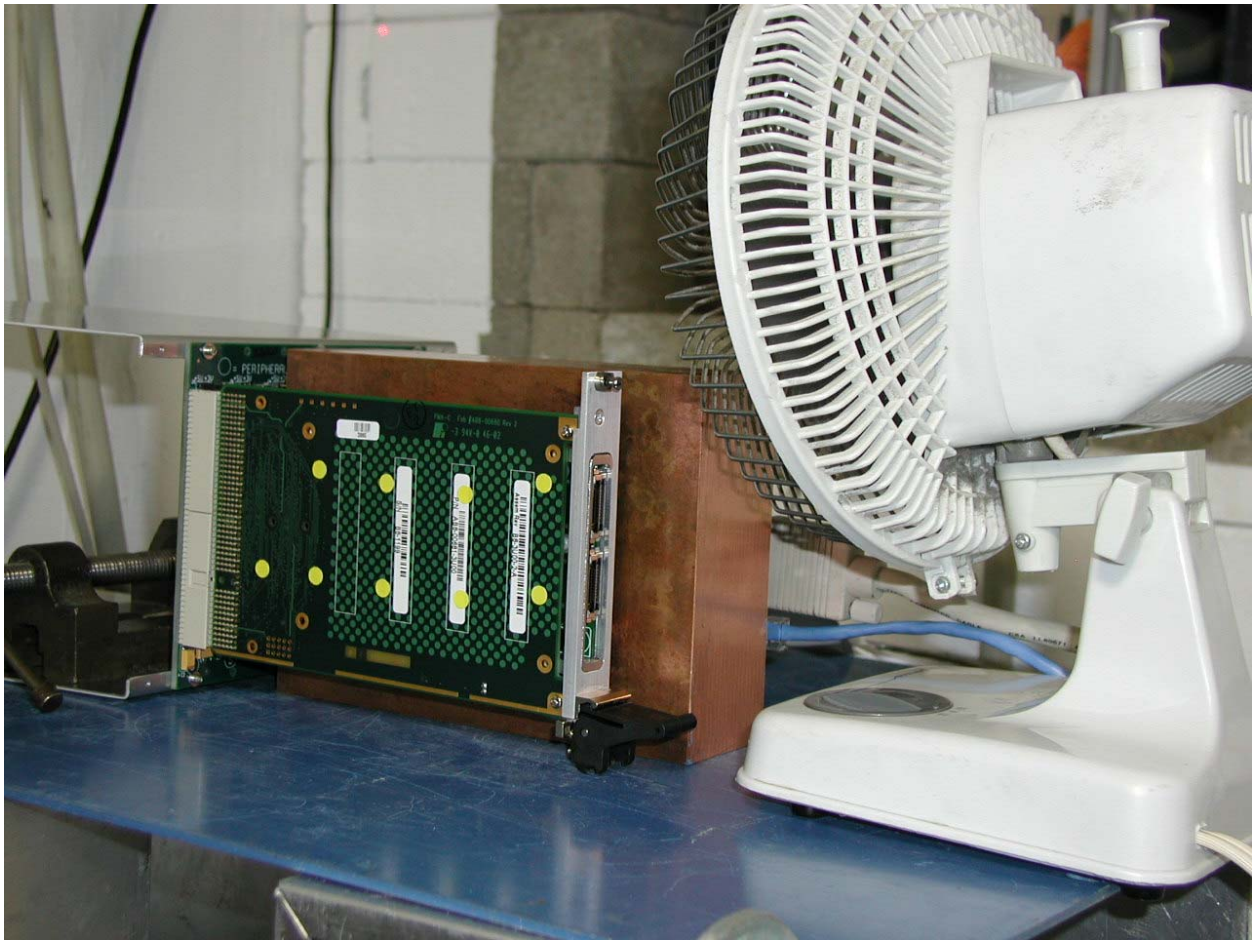

FIGURE 3. Bittware Quad 21160 Sharc DSP Board

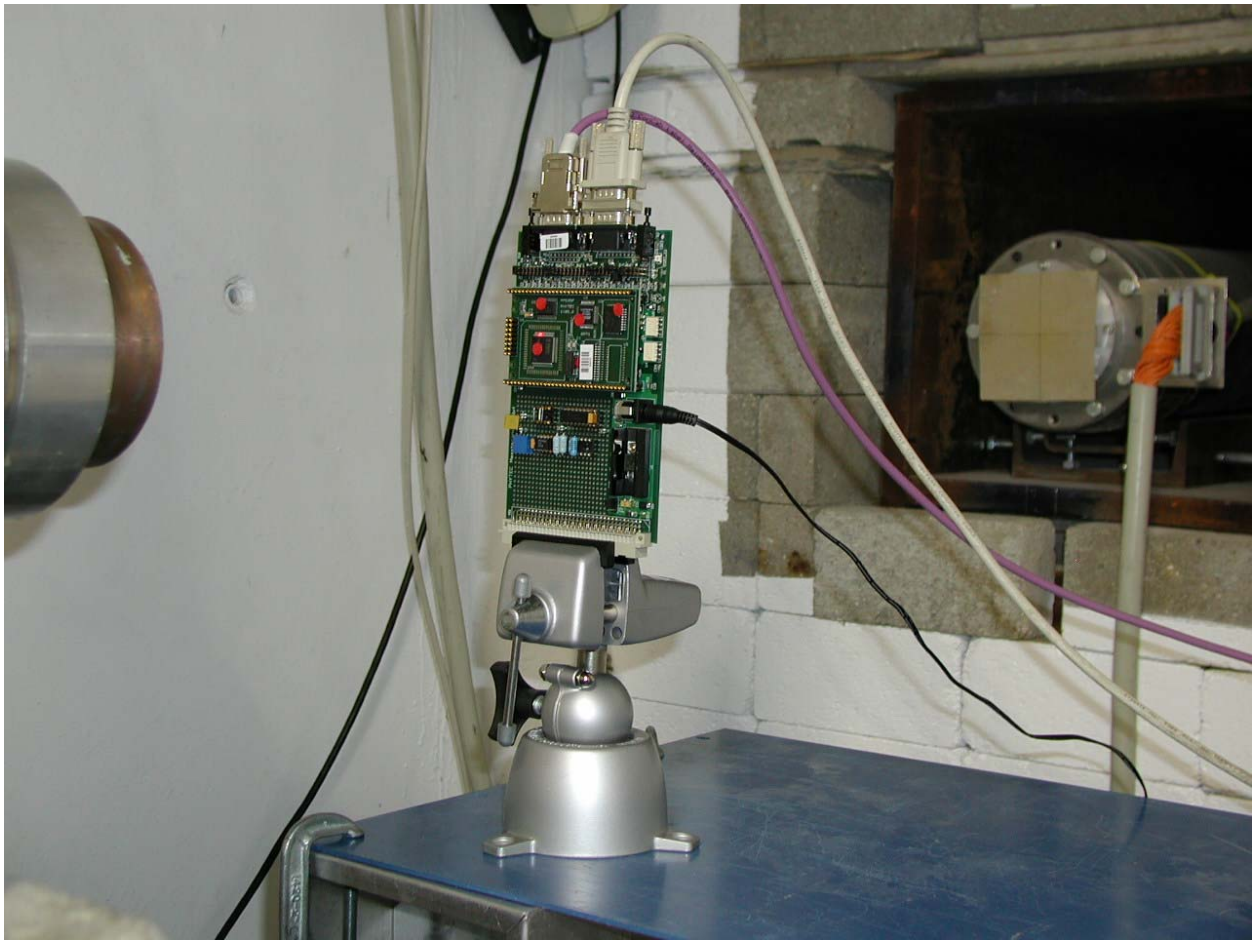

FIGURE 4. Phytec miniMODUL-515 CAN Module

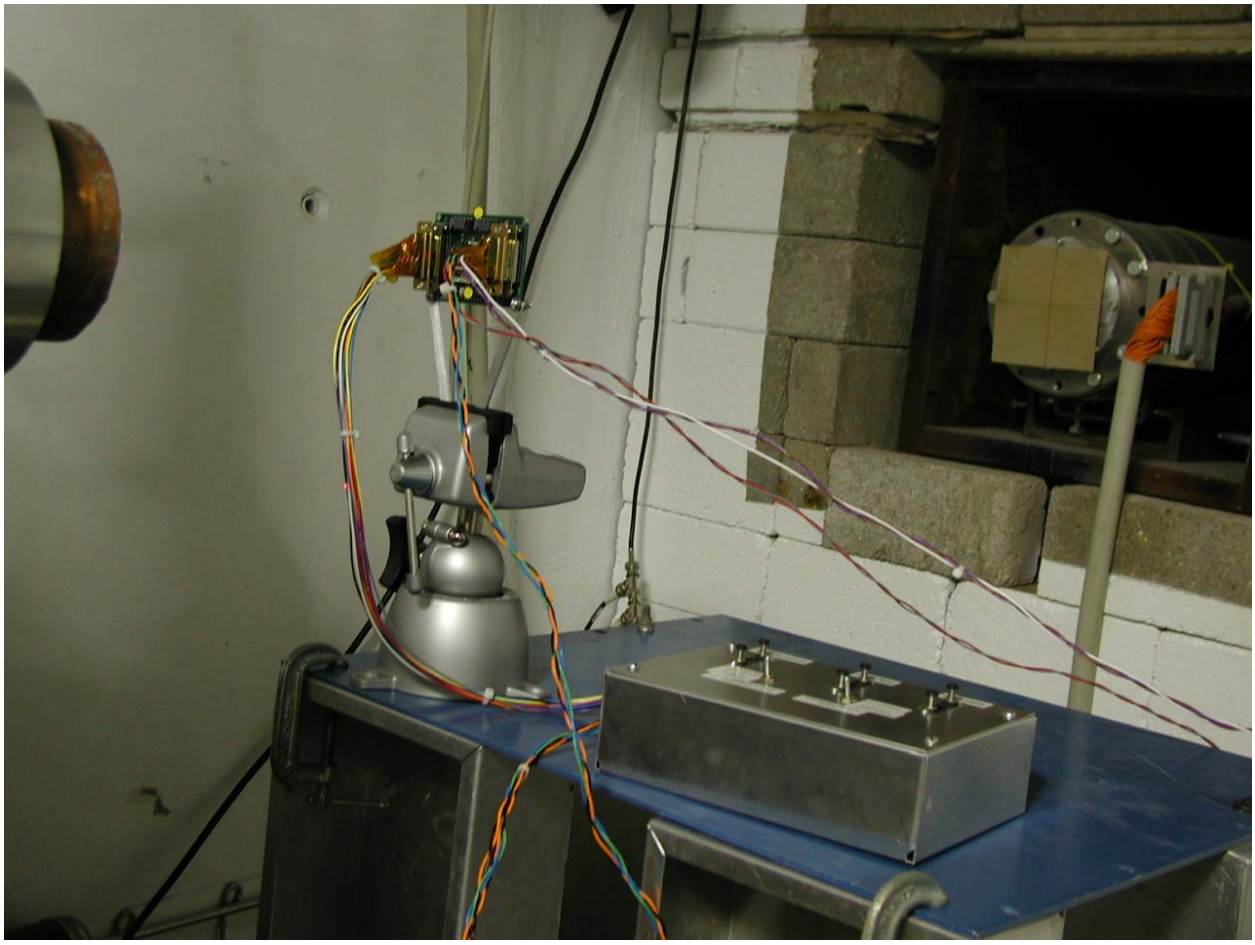

FIGURE 5. Custom Designed FOMA Valve Timer

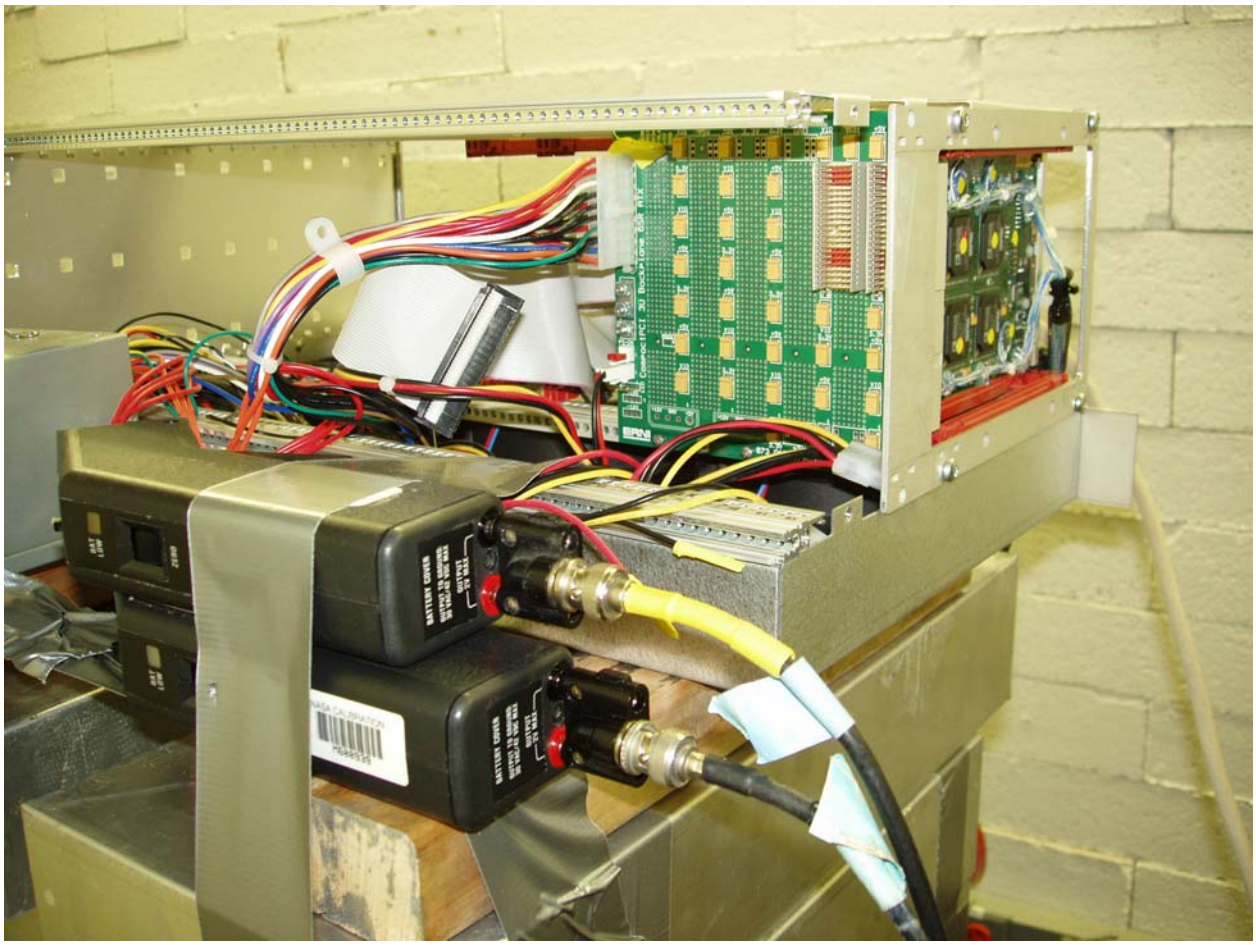

FIGURE 6. Bittware Quad HS3U “Space” DSP Board (prototype)

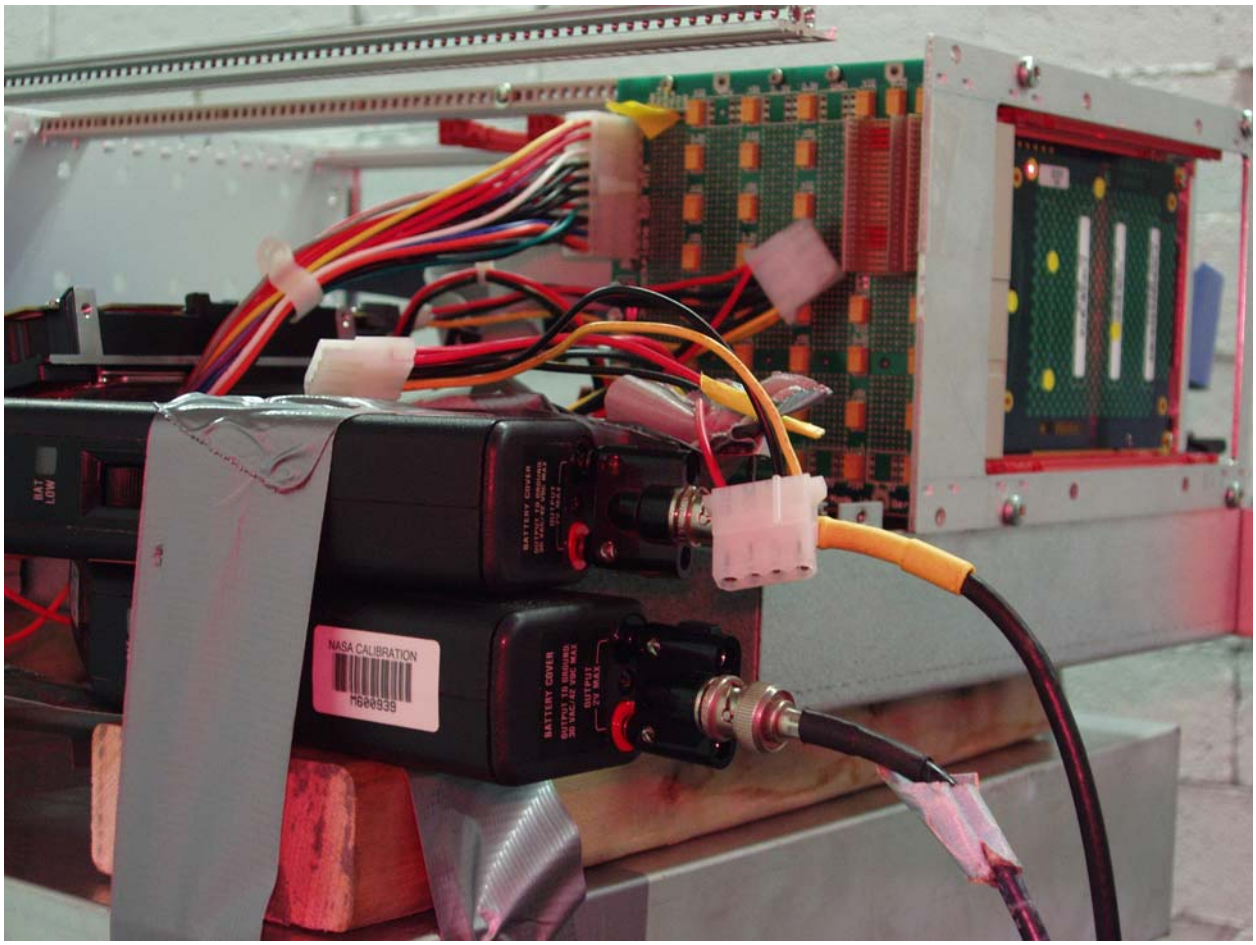

FIGURE 7. VMIC VMIPC-5790 Ultra 160 SCSI Controller

2.0 DOCUMENTS

This section lists specifications, models, standards, guidelines, handbooks, and other special publications. These documents have been grouped into two categories: applicable documents and reference documents.

2.1 Order of Precedence for Documents

In the event of a conflict between this document and other documents specified herein, the requirements of this document shall apply. In the event of a conflict between this document and the contract, the contractual requirements shall take precedence over this document. In the event of a conflict between this document and higher-level documents, the higher-level documents shall take precedence over this document.

All documents used, applicable or referenced, are to be the issues defined in the current version of the MRDOC contract. Nothing in this document supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.2 Applicable Documents

The documents in Table 1 are applicable to the FCF Project to the extent specified herein.

TABLE I. Applicable Documents

FCF-TPP-0761	Radiation Susceptibility Test Plan for the Fluids and Combustion Facility (FCF)
SSP30512	Space Station Ionizing Radiation Design Environment
SSP50005	ISS FLIGHT CREW INTEGRATION STD (NASA-STD-3000/T)

2.3 Reference Documents

The documents in Table 2 are provided only as reference material for background information and are not imposed as requirements.

TABLE II. Reference Documents

IEEE Trans. On Nucl. Sci. **45**, 2467-2474 (1998)	Internuclear Cascade-Evaporation Model for LET Spectra of 200 MeV Protons
LLIS Database Entry 0792	Radiation Design Margin Requirement
LLIS Database Entry 0824	Space Radiation Effects on Electronic Components in Low-Earth Orbit
NASA/CR-1998-208593	Space Environment Effects: Low-Altitude Trapped Radiation Model
PD-ED-1258	Space Radiation Effects on Electronics Components in Low-Earth Orbit

3.0 TEST SUMMARY

The testing was conducted at the Indiana University Cyclotron Facility (IUCF) in Bloomington Indiana. The test was setup and instrumented according to FCF-TPP-0761, Fluids and Combustion Facility Radiation Susceptibility Test Plan.

The individual run results are found in Appendix B, D, and F.

The purpose of this test is to determine the MTBF of various electronic components due to Single Event Effects (SEE). The components will be subjected to a 200 MeV proton beam (Indiana University) to a total fluence of 1 E ^{10} p^+/cm^2. Components will be monitored during exposure to determine when an error occurs as well as what type of error. A fluence of 1 E ^{10} p^+/cm^2 provides a Total Ionizing Dose (TID) of 600 rad (Si) This provides an approximate 2 times safety factor versus the expected Total Ionizing Dose as specified in SSP30512 (corresponding verification was found in SSP50005 involving human exposure to ionizing radiation). Use of 200 MeV protons probes the linear energy transfer (LET) region to 14 MeV cm^2/mg in Silicon. Given the USLab environment, probing out to 14 MeV/μm gives an upper limit of 10 years MTBF. Thus, a null result (no errors) means a component has at least a 10-year MTBF. Note that this holds only for Silicon using a data analysis program developed by Johnson Space Center (PRODUCT). Interpretation of effects on non-Silicon based components (i.e. crystalline optics) requires a different LET for 200 MeV protons, which can be calculated knowing the cross section of the material. Results can be found in Appendix C, Appendix E, and Appendix G as the consolidated output files created from the PRODUCT software.

4.0 RESULTS

4.1 Impacts Of Identified Single Event Effect Occurrences on Operational Availability

4.1.1 Custom Designed FOMA Valve Timer

There is no reported impact on the operational availability of the Custom Designed FOMA Valve Timer and subsequently the FOMA as a result of testing the Custom Designed FOMA Valve Timer. No errors were encountered.

4.1.2 Phytec mini-MODUL-515-CAN Controller Board

There is no reported impact on the operational availability of the FCF as a result of testing the Phytec mini-MODUL-515-CAN Controller Board. Only one error was encountered producing an overall MTBF of 676 days. The board function auto-corrected itself once the error was flagged therefore leading to the conclusion that this error will have no operational availability impact. Subsequent in-lab testing produced the same type error, indicating that the error observed was most likely not a direct result of exposure to ionizing radiation.

4.1.3 DY-4 SVME179-1440 Single Board Computer and the I/OP DY-4 Dual Channel 1553B PMC-601 Board

The errors that were encountered while testing the I/OP/FCU DY-4 SVME179-1440 Single Board Computer and the I/OP DY-4 Dual Channel 1553B PMC-601 Board, produced an overall MTBF of 16.4 days. These errors consisted of functional interrupts and data corruption errors. In most instances a recycling of power to the Single Board Computer was needed to correct the error.

When the I/OP Main Processor (DY-4 Single Board Computer) sees a non-destructive ionizing radiation event that precludes the “heart-beat” signal from being received by the I/OP CANbus Processor (3 consecutively missed signals), the CANbus Processor will try to reboot the Main Processor. This problem will be recognized by ISS and ground personnel because of the loss of required health and status data. Ground personnel will have to perform some level of root cause analysis to determine the cause of this lost data, and will take appropriate actions to reinitialize the I/OP for proper operations. All I/OP attributes will be re-verified prior to experiment progressions starting or continuing.

When the I/OP High Rate Data Link (HRDL) Processor (DY-4 Single Board Computer) sees a non-destructive ionizing radiation event that precludes the HRDL signal from being received by ISS or ground personnel, ground personnel will have to take action. At this point ground personnel will command the I/OP to cycle power to the I/OP HRDL Processor in an attempt to restore I/OP HRDL Processor functionality. If I/OP HRDL Processor functionality is not restored, ground personnel will have to perform some level of root cause analysis to determine the cause of this lost signal. Experiment progression can continue if downlink capability through the HRDL is not mandatory for experiment success. If power cycling restores I/OP HRDL Processor functionality, all I/OP attributes will be re-verified prior to experiment progressions starting or continuing.

When the FCU Single Board Computer sees a non-destructive ionizing radiation event that precludes the health and status signal from being received by the I/OP (3 consecutively missed signals), the I/OP will power down the FCU, will place all packages into an “idle mode”, will place all FOMA hardware into a “safe-mode”, and report the loss of this health and status signal to ground personnel. Ground personnel will have to perform some level of root cause analysis to determine the cause of this lost signal, and will take appropriate actions (i.e. cycle power to the FCU) to reinitialize the FCU for proper operations. All FCU attributes will be re-verified prior to experiment progressions starting or continuing.

4.1.4 PEP CP-302 Single Board Computer

The errors that were encountered while testing the IPSU/FSAP PEP CP-302 Single Board Computer produced an overall MTBF of 15.3 days. These errors consisted of functional interrupts and data corruption errors. In most instances a recycling of power to the Single Board Computer was needed to correct the error.

When the IPSU Single Board Computer sees a non-destructive ionizing radiation event that precludes the health and status signal from being received by the I/OP (five minute duration for determination of a potential auto-reboot condition), the I/OP will power down the IPSU, will place all other packages into an “idle-mode”, and report the lose of this health and status signal to ground personnel. Ground personnel will have to perform some level of root cause analysis to determine the cause of this lost signal, and will take appropriate actions (i.e. cycle power to the IPSU) to reinitialize the IPSU for proper operations. All IPSU attributes will be re-verified prior to experiment progressions starting or continuing. The IPSU will maintain current test point set-ups to allow continued experiment progression if IPSU health and status is re-obtained and re-verified.

When the FSAP Single Board Computer sees a non-destructive ionizing radiation event that precludes the health and status signal from being received by the I/OP (3 consecutively missed signals), the I/OP will power down the FSAP, will place all packages into an “idle mode”, and report the loss of this health and status signal to ground personnel. Ground personnel will have to perform some level of root cause analysis to determine the cause of this lost signal, and will take appropriate actions (i.e. cycle power to the FSAP) to reinitialize the FSAP for proper operations. All FSAP attributes will be re-verified prior to experiment progressions starting or continuing.

A second PEP CP-302 Single Board Computer was tested which produced a destructive event MTBF of 1,450 days. Root cause analysis performed by PEP/Kontron produced the following results as reported from PEP/Kontron:

> We determined that IC18 on the CP302-Baseboard failed (see attached, p2). This is the Altera EPM7128STC100-15 PLD (http://www.altera.com/literature/ds/m7000.pdf). The failure was due to overvoltage being applied to the PLD. Overvoltage is a general term we use to describe a chip that's fried. I can look into possible board-related causes, but given the nature of your testing, I don't know if that would help you any.

The Altera IC referenced above was being exposed to ionizing radiation when the destructive event occurred.

No additional testing of the PEP/Kontron CP-302 Single Board Computer is planned as the destructive event had a relatively large MTBF at a 100% duty cycle. This MTBF will on average double as duty cycles are accounted for.

4.1.5 Bittware DSP Sharc Board

The errors that were encountered while testing the IPSU Bittware DSP Sharc Board produced a destructive event MTBF of 319 days and 1,440 days. These errors were fully destructive, and the two MTBF values presented above were for one unique position on each of the two distinct boards that were tested. Therefore the MTBFs presented above only represent the failure rates for the components within the unique zones in question, and by no means reflect the entire boards total MTBF. Additional testing is planned for this board, and will be added to this test report accordingly.

Both units were verified to have non-functional DSP chips (even though the DSP chips were not specifically exposed to the direct ionizing radiation beam) when the boards were returned to Bittware for analysis. See additional information as obtained in our September, 2003 testing involving the potential for stray proton effects.

Addendum for September 2003 testing of additional IPSU Bittware DSP Sharc Boards (See Appendix D and E for specific test results and analyses):

Two additional IPSU Bittware DSP Sharc Boards were taken back to the IUCF in September 2003 for additional testing. The primary card was set-up and proper operation verified. The ionizing radiation beam required “tuning” and we did not have beam available until 11:30 PM. We arrived at approximately 8:00 PM and we powered up the hardware to be tested for additional verification that the set-up was still functioning. A full battery of tests was ran, and all operations were verified. WE DID NOT POWER DOWN THE SYSTEM. Approximately an hour later we noticed (through the loss of our VGA screen) that we had lost functionality of the primary Bittware DSP card. We saw an over current condition in the test set-up (3.3 Volt current increased from nominal 3.58 Amps to 4.52 Amps, the over current limit on the power supply). After discussions with the

IUCF personnel, we concluded that “stray protons” (typically on the order of 1/1,000 to 1/10,000 the rate of full beam exposure and on the order of half the energy, i.e. 100 MeV) from the beam tuning operation had impacted the card and rendered it inoperable.

Upon return, DSP Chip # 2 was found to be non-functional.

When beam was restored at 11:30 PM we carefully replaced the Bittware card with our spare, and also replaced the Single Board Computer (to be on the save side). We verified proper operations, and then proceeded in exposing position number seven (individual Analog Devices DSP chip # 3) to a slow rate of proton exposure that was expected to take approximately 30 minutes for full fluence (1 E +10 protons/cm2). We saw an initial anomaly when the beam was initially provided, but the IUCF shut it self down after an approximate 0.25 second exposure (< 1 E +6 protons/cm2). This was facility related. We saw an over current condition in the test set-up (3.3 Volt current increased from nominal 3.58 Amps to 4.52 Amps, the over current limit on the power supply) as a result of this extremely short exposure. Removal of power corrected this initial anomaly. An interim test was run with beam stops (Faraday Cup) in place to rule-out any extraneous Neutron effects, and all looked good. Our first formal run ended after approximately 7 seconds of exposure, experiencing a total exposure of 3.129 E +7, or 0.31% of total fluence (This equates to a 5.5-day MTBF, but I question the validity with only one data point. In addition this would be the MTBF for only one of four DSP chips). This was a destructive event that was not recoverable and included an over current condition as seen previously (3.3 Volt current increased from nominal 3.58 Amps to 4.52 Amps, the over current limit on the power supply).

Upon return, DSP Chip # 3 was found to be non-functional. This is the DSP chip in test position number 7.

An additional estimate was performed to simulate the effect if all four DSP chips on the card were to be exposed and failed in a like duration, resulting in a 1.5 day MTBF just for exposing the four DSP chips to an equivalent dose of ionizing radiation.

A NGIT/NASA committee has been formulated to address mitigation plans for this highly susceptible COTS card.

4.1.6 Bittware Quad HS3U “Space” DSP Board (prototypes)

Background:

The FCF Ionizing Radiation Testing team tested four Bittware Hammerhead Space boards at the Indiana University Cyclotron Facility during the week of March 22nd, 2004. The boards have over-current circuit protection circuitry incorporated into the current Hammerhead DSP board design in the hope that it would save the DSP chips from being destroyed in an ionizing radiation environment. The Bittware Design Engineer, CW Thomas, was present for the first 2 days of testing.

Prior to radiation testing, the boards were functionally tested and characterized for power draw in different operating modes. The V_{IO} (3.3V supply) current characteristics were difficult to characterize. Hammerhead DSP chip 1 has control over the V_{IO} bus and had a nominal current draw of 14 mA, while the other three DSP chips drew 8 mA in their high power mode. Each DSP chip operates with severe transients during operation and we determined that the V_{IO} current limit for DSP chip #1 be set at 208 mA, the other three DSP chips were V_{IO} current limited at 30 mA. The boards would not consistently operate without tripping the current switches at a lower current limit. The V_{Core} (2.5 V supply) current draw was measured to be between approximately 600 mA and 615 mA in its high power mode. The V_{Core} current limit was set to 708 mA for all 4 DSP chips. These values were concurred by Bittware as being the lowest values without unintended current trips during normal operation of the Hammerhead Space boards.

Each of the four Hammerhead boards were tested and determined to be functional prior to testing of the boards at the IUCF. There were some issues with the boards that needed to be overcome (see the summary Radiation Test Summary written by Doug Reese).

During testing, the status of the Bittware Hammerhead Space boards were monitored via software feedback and graphically via a LabVIEW program running on a lap top computer. The card cage input current was also monitored.

Test Results:

The FCF Ionizing Radiation Test team has not had a chance to analyze the data. The results in this report will be more general in nature, ie. no specific board serial numbers, the specific DSP chip targeted and the fluence at which errors occurred. We hope to have a summary of the specific information at the meeting on Tuesday. I refer to 3 recoverable interrupts in my summary, in reality it was 1 to 3, but I don't have that data available to me at this time.

We began testing by specifically targeting one of the DSP chips, Hammerhead DSP chip #2. The boards were operated in the 7x7 convolution mode for the highest current draw. The current interruption circuitry was operated in "Auto Shutdown mode", the mode they were to operate in flight. Auto shutdown mode also offers the fastest current turn off time. The board experienced a current interrupt very quickly, on the order of 1 to 3 seconds of testing at the lowest fluence rate possible at the IUCF. The board survived about 3 recoverable current trips before experiencing a destructive failure a fluence of < 3% of the intended total dose. The board was analyzed at determined that the V_{Core} power supply for the targeted DSP chip was shorted to ground, ~0.8 Ohms, on the DSP chip in question. The nominal V_{Core} power supply resistance to ground is ~820 Ohms.

We then targeted the current interruption circuitry for Hammerhead DSP #2 on a second board. We obtained similar results; the DSP chips experienced about 3 recoverable current trips before experiencing a destructive failure. The failures were at a higher fluence level, but it was disturbing that the DSP chips were experiencing any effects from the proton beam because they were not being targeted. Again the board was analyzed at determined that the V_{Core} power supply for the targeted DSP chip was shorted to ground, ~0.8 Ohms, on the DSP chip in question.

The 2 damaged boards were taken to PTS Electronics, a board house in Bloomington. They replaced the two damaged DSP chips in a few hours. We tested the boards after they were returned and they were fully functional.

After analyzing the test data we obtained, we had a discussion with CW Thomas to determine if there was anything else that could be learned from further radiation testing. We decided to test another board running in 7x7 convolution mode, but in "Manual Shutdown Mode. We had the advantage of seeing which DSP chip tripped the current switch, but it happened slower than in Auto Mode. We didn't see much difference in board performance. The board survived about 3 recoverable current trips before experiencing a destructive failure. The board was analyzed at determined that the V_{Core} power supply for the targeted DSP chip was shorted to ground, ~0.8 Ohms, on the DSP chip in question. We also noted that another DSP chip V_{Core} power supply resistance to ground was ~600 Ohms. The chip was functional, but we think that it was degraded from its original state.

We then removed the crowbar FETs from the current interruption circuitry and that also had no effect on the board performance. The board survived about 3 recoverable current trips before experiencing a destructive failure. The board was analyzed at determined that the V_{Core} power supply for the targeted DSP chip was shorted to ground, ~0.8 Ohms, on the DSP chip in question.

Again the 2 damaged boards were taken to PTS Electronics, a board house in Bloomington. They replaced the two damaged DSP chips in a few hours. We tested the boards after they were returned and they were fully functional.

We contacted the radiation group at JSC for any further testing ideas, but they were at a loss for any suggestions. With almost nothing left to try, we decided to test using a lower beam energy. There have always been questions as to whether we were over-testing with a beam energy of 200 MeV, so we thought we might be able to answer those question. We requested the facility to supply a 54 MeV proton beam, the lowest energy level they are capable of supplying. This was accomplished by inserting a 1-1/2" copper block between the beam and our board, essentially shielding the board from the incoming radiation. Again, we observed no effect on the board performance. The board survived about 3 recoverable current trips before experiencing a destructive failure. The board was analyzed at determined that the V_{Core} power supply for the targeted DSP chip was shorted to ground, ~0.8 Ohms, on the DSP chip in question.

We decided to try one final test. We went back to a 200 MeV beam and tested the boards in "Idle Mode." In Idle Mode, the V_{IO} current draw was similar to the 7x7 convolution mode, but the V_{Core} power draw was only 325 mA. We didn't alter the current limit values for this testing. During the testing in Idle Mode, we experienced 13 recoverable current interruptions, but none were destructive. These errors also were happening at a very high rate.

We learned from Bittware that the DSP chips are not using the DMA capability to communicate with each other while operating in Idle Mode. We asked for Doug Reese to produce a mode of operation where the DSP chips are working, but not utilizing the DMA capability. He e-mailed us the program and we ran the board in the "Primes Mode" that he programmed. We tested the board in this mode and experienced 9 recoverable current interrupts before finally experiencing a

destructive failure. Once again, the board was analyzed at determined that the V_{Core} power supply for the targeted DSP chip was shorted to ground, ~0.8 Ohms, on the DSP chip in question.

All of the DSP chip failures were attributed to a short of the V_{Core} power supply to ground. This is consistent with 90% of the DSP chip architecture consisting of hardware being supplied by V_{Core} power.

(See Appendix F and G for specific test results and analyses), but the below summary details the results of testing from March 2004:

TABLE III. Summary Results From March 2004 Testing

Bittware Space Board Serial Number	Hammerhead Operational Mode	IC Targeted By The Proton Beam	MTBF For Recoverable Events [Days]			MTBF For Destructive Events [Days]		
			Per IC	Per Board	Per IPSU	Per IC	Per Board	Per IPSU
1004	7x7 Convolution Auto Shutdown Mode	DSP #2	7.5	1.9	0.9	35.6	8.9	4.5
1002	7x7 Convolution Auto Shutdown Mode	DSP #2 Current Limiting Circuitry	345	86.3	43.1	857	214.3	107.1
1001	7x7 Convolution Auto Shutdown Mode	DSP #4 Current Limiting Circuitry	N/A	N/A	N/A	477	119.3	59.6
1001	7x7 Convolution Maunal Shutdown Mode	Sharc Fin	169	42.3		N/A	N/A	N/A
1001	7x7 Convolution Maunal Shutdown Mode	DSP #4	N/A	N/A	N/A	8.9	2.2	1.1
1002	7x7 Convolution Maunal Shutdown Mode Crowbar FET Removed	DSP #1	7.3	1.8	0.9	27.1	6.8	3.4
1004	Idle Mode Auto Shutdown Mode	DSP #2	5.1	1.3	0.6	N/A	N/A	N/A
1002	Primes Mode No DMA Function) Auto Shutdown Mode	DSP #3	4.6	1.2	0.6	56	14.0	7.0

A NGIT/NASA committee is still convening to address mitigation plans for this highly susceptible COTS prototype card.

4.1.7 VMIC VMIPC-5790 Ultra 160 SCSI Controller

The errors that were encountered while testing the IPSU VMIC VMIPC-5790 Ultra 160 SCSI Controller produced an overall MTBF of 34.8 days. These errors consisted of functional interrupts. In most instances a recycling of power to the SCSI Controller was needed to correct the error.

When the IPSU SCSI Controller sees a non-destructive ionizing radiation event that…….

When the FSAP SCSI Controller sees a non-destructive ionizing radiation event that…….

When the MDSU SCSI Controller sees a non-destructive ionizing radiation event that…….

5.0 CONCLUSSIONS

5.1 Comparison to Success Criteria

As a result of a review of susceptibility of ionizing radiation induced events (did we see any errors), occurrence of ionizing radiation induced events (MTBF), and subsequent mitigation philosophies for the specific hardware tested during these rounds of testing, the results of this testing produced ionizing radiation induced events that may lead to termination of experiment progressions that are underway. The true impact on operational availability is difficult to determine, depending on the exact point within an experiment progression that these downing events occur. Most of these events will require a powering down of rack operations to reinitialize all packages to a functional state.

6.0 RECOMMENDATIONS

6.1 Testing Recommendations

From this initial round of ionizing radiation testing the following recommendations are being noted for subsequent planned testing.

*Record as much information as possible to describe the error in question (i.e. current increase versus nominal, source of error if it can be determined, detailed information on the type of corrupted data).

*Record as much information as possible about the recovery methodology utilized to recover from the error (i.e. keystrokes utilized to recover, recycling of power, current draw after recovery).

*Provide as much cross training (multi-tasking) as possible for test team members to assist in a steady flow of testing.

*Provide access to a printer to capture actual ionizing radiation based RAM or memory error data for subsequent review during test root cause analysis.

*Develop the capability to perform some type of current limiting at the power supply to minimize the chances of encountering a truly destructive event. This will require a full understanding of true base line nominal current draws under maximum nominal conditions.

6.2 Lessons Learned

From this initial round of ionizing radiation testing the following lessons learned are being documented for subsequent planned testing.

*Verify adequate function of test set-up utilizing actual test support hardware, as it will be configured at the IUCF in the lab prior to departure to the IUCF.

*An attempt to pre-classify known error types (i.e. Single Event Latchups that are corrected by an auto-reset of board function, Single Event Latchups that are corrected by a recycle of power to obtain board function, a RAM or memory error) and then consistently utilize these pre-defined error classifications throughout subsequent testing.

*There may not be a need to attempt to isolate each individual chip or small groups of chips for each ionizing radiation exposure. Based upon functionality, we may be able to identify zones on printed circuit boards versus trying to isolate to smaller individual chips or small groups of chips. Larger target areas can potentially speed up the testing and allow for a greater amount of hardware to be tested within a given timeframe.

APPENDIX A ACRONYMS

ATCU	Air Thermal Control Unit
CIR	Combustion Integrated Rack
ECS	Environmental Control System
FCF	Fluids and Combustion Facility
FI	Functional Interrupt
FIR	Fluids Integrated Rack
FSAP	Fluids Science Avionics Package
GRC	Glenn Research Center
HRDL	High Rate Data Link
I/OP	Input/Output Processor
IPSU	Image Processing Storage Unit
ISS	International Space Station
IUCF	Indiana University Cyclotron Facility
JSC	Johnson Space Center
LET	Linear Energy Transfer
MDM	Multiplexer-Demultiplexer
MIP	Mission Integration and Planning
MRDOC	Microgravity Research, Development, and Operations Contract
MTBF	Mean Time Between Failures
NASA	National Aeronautics and Space Agency
SAA	South Atlantic Anomaly
SCSI	Small Computer System Interface
SEB	Single Event Burnout
SEE	Single Event Effects
SEL	Single Event Latchup
SEU	Single Event Upset
TID	Total Ionizing Dose
TSC	Telesciences Support Center

APPENDIX B RESULTS OF PROTON BEAM TESTING OF FCF COMPONENTS PERFORMED IN MARCH 2003

Run No.	Assembly	Position No.	Component ID	Component No.	Component Description	Vignette	Fluence	Percentage of Full Dose	Results
1	FOMA Valve Timer	1	[U5]	Atmel - AT89S8252-24AI	Microcontroller	1 X 1.5	1.00E+10	100.00%	No Errors
			[U1]	Littlefuse - SP723AB	ESD Overvoltage				
			[U2]	Littlefuse - SP723AB	ESD Overvoltage				
			[Y1]	Citizen - CM30PA11.0592MABJT	Crystal				
2	FOMA Valve Timer	2	[U8]	Analog Devices - ADM233LAN	RS-232 Chip	1 X 1.5	1.00E+10	100.00%	No Errors
			[U6]	Littlefuse - SP723AB	ESD Overvoltage				
3	FOMA Valve Timer	3	[U3]	Phillips - 74HC04N	Logic Inverter	1 X 1.5	1.00E+10	100.00%	No Errors
			[U4]	Phillips - 74HC11N	Logic AND				
4	Phytec miniMODUL-515 CAN Controller	1	[U1]	Siemans - SAB-C515C-LM	Microcontroller - CAN, DIO, ADC, TIMER	1 X 1	1.00E+10	100.00%	No Errors
			[U7]	MAXIM - MAX690CSA	Micro Supervisor				
5	Phytec miniMODUL-515 CAN Controller	2	[U2]	TI - 74HC573	Latch - ADDR/DATA Bus Multiplex	1 X 1	1.00E+10	100.00%	No Errors
			[T3]	???? - 2N7002	Transistor (Not used with SAB-C515C-LM microcontroller)				
6	Phytec miniMODUL-515 CAN Controller	3	[U3]	AMD - 29F010	Flash Memory	1 X 1	1.00E+10	100.00%	No Errors Performed Power Cycle Reset @ 1/4 total dose. Performed Software Reset @ 4/5 total dose. Performed Software Reset @ total dose.
			[T2]	???? - 2N7002	CS2 Lock-Out				

Run No.	Assembly	Position No.	Component ID	Component No.	Component Description	Vignette	Fluence	Percentage of Full Dose	Results
7	Phytec miniMODUL-515 CAN Controller	4	[U4]	Sony - 431024	SRAM:8X32K	1 X 1	3.78E+09	37.80%	(F1) Pulse Count/Counter Error Corruption. Balance of Telemetry through RS-232 OK. Single count Error- Auto Corrected.
			[U8]	MAXIM - MAX202CSA	RS232 TRANSCVER				
			[XT1]	???? - ????	Crystal - MICRO CLOCK				
			[T1]	???? - 2N7002	CS1 Lock-Out				
8	Phytec miniMODUL-515 CAN Controller	4					1.00E+10	100.00%	No Errors Additional error occurred after beam removal, Value of data H2=32611664.
9	Phytec miniMODUL-515 CAN Controller	5	[U6]	Altera - EPM7032QC44-12	PLD	1 X 1	1.00E+10		No Errors
			[U9]	Philips - PCA82C250T	CAN Interface				
10	Bittware DSP Sharc Card	1	[U1]	Microchip - 24LC02B	I2C EEPROM Memory	1 X 1.5	1.18E+09	11.80%	(F1) Functional Interrupt (t-shell). PC crashed with Automatic Reboot (slightly delayed). Slight increase in 5.00 Volt current from 1.3 A nominal to 1.6 A.
			[U2]	Dallas - DS1832U	Micro Monitor IC				
			{U7}	Quick Logic - QL5064	PMC INTERFACE: PCI, SDRAM, DUART CONTROLLER				

Run No.	Assembly	Position No.	Component ID	Component No.	Component Description	Vignette	Fluence	Percentage of Full Dose	Results
11	Bittware DSP Sharc Card	1					4.20E+09	42.00%	(F2) Current increase error. 3.3 Volt current from 4.10 A nominal to 5.28 A. Potential Latch. Test Program Ran. Recycled Power, and current returned to nominal.
12	Bittware DSP Sharc Card	1					5.47E+09	54.70%	(F3) Functional Interrupt (t-shell). PC crashed with no Automatic Reboot. Recycled Power. Slight increase in 5.00 Volt current from 1.3 A nominal to 1.6 A.
13	Bittware DSP Sharc Card	1					6.23E+09	62.30%	(F3) Functional Interrupt (t-shell). PC crashed with no Automatic Reboot. Recycled Power. Slight increase in 5.00 Volt current from 1.3 A nominal to 1.6 A.
14	Bittware DSP Sharc Card	1					9.26E+09	92.60%	(F2) Current increase error. 3.3 Volt current from 4.10 A nominal to 5.15 A. Potential Latch. Test Program Ran. Recycled Power, and current returned to nominal.

Run No.	Assembly	Position No.	Component ID	Component No.	Component Description	Vignette	Fluence	Percentage of Full Dose	Results
15	Bittware DSP Sharc Card	1					9.73E+09	97.30%	(F1) Functional Interrupt (t-shell). PC crashed with Automatic Reboot.
16	Bittware DSP Sharc Card	1					9.85E+09	98.50%	No errors. Ran out to 9.85E+09 (98.5% of full dose equivalent)
17	Bittware DSP Sharc Card	2	[U8]	IDT - IDTSQ33X257Q1	MUX/DMUX	1 X 1.5	1.83E+08	1.83%	(F1) Error, flipped bit during PC Self Address Test
			{U13}	Fairchild Semiconductor - 74LCX244MTC	BUF/LINE DRIVER				
			[U14]	National Semiconductor - PC16552DV	Dual UART				
			{U15}	AMD - AM29LV160BT90REC	Flash Memory: BOOT CODE, GEN. STORAGE				
			{U20}	Sipex - SP232AEN	RS232 Line Drvr/Rcvr				
			{Y2}	CTS - CB3-3C-18.4320-T	Clock Oscillator:DUART				
18	Bittware DSP Sharc Card	2					5.40E+08	5.40%	Errors Caught On the Fly, Beam Paused (F1) Error, flipped bit during PC Self Address External Bank Test (4 errors)
							1.18E+09	11.80%	Errors Caught On the Fly, Beam Paused (F1) Error, flipped bit during PC Self Address Compliment Test (6 errors)

Run No.	Assembly	Position No.	Component ID	Component No.	Component Description	Vignette	Fluence	Percentage of Full Dose	Results
							1.24E+09	12.40%	Errors Caught On the Fly, Beam Paused (F1) Error, flipped bit during PC Checkerboard A Test (7 errors)
							1.58E+09	15.80%	Errors Caught On the Fly, Beam Paused (F1) Error, flipped bit during PC Checkerboard 5 Test (2 errors)
							2.50E+09	25.00%	Errors Caught On the Fly, Beam Paused (F1) Error, flipped bit during PC All Bits Set Test (8 errors)
							2.53E+09	25.30%	Errors Caught On the Fly, Beam Paused (F1) Error, flipped bit during PC All Bits Clear Test (3 errors)
							5.41E+09	54.10%	Errors Caught On the Fly, Beam Paused (F2) High Current Condition, 3.3 Volt current spiked from nominal 4.6 A to 5.9 A. Recycled Power, and current returned to nominal.

Run No.	Assembly	Position No.	Component ID	Component No.	Component Description	Vignette	Fluence	Percentage of Full Dose	Results
							5.90E+09	59.00%	Errors Caught On the Fly, Beam Paused (F1) Error, flipped bit during PC Random Numbers Test (8 errors)
							6.87E+09	68.70%	Errors Caught On the Fly, Beam Paused (F1) Error, flipped bit during PC Self Address Compliment Test (1 error)
							7.07E+09	70.70%	Errors Caught On the Fly, Beam Paused (F1) Error, flipped bit during PC Checkerboard A Test (1 error)
							8.01E+09	80.10%	Errors Caught On the Fly, Beam Paused (F2) High Current Condition, 3.3 Volt current spiked from nominal 4.6 A to 7.8 A. Recycled Power, and current still high at 5.8 A. A number of tests were ran, with many errors (9,230,671 errors in Self Address Compliment Test). DESTRUCTIVE EVENT.

Run No.	Assembly	Position No.	Component ID	Component No.	Component Description	Vignette	Fluence	Percentage of Full Dose	Results
19	PEP CP302 SBC	1	[U8]	Integrated Circuit Systems - ICS9248BF-98	System Clock Generator	1 X 1.5	2.53E+09	25.30%	(F1) SBC Error in RAM Verification (3.3 Volt current spiked from nominal 4.0 A to 4.5 A). Upon test software shutdown, SBC crashed. Recycled power and rebooted effectively.
			[XT1]	???? - 14a318/HCJ 9L	Clock Gen.				
			{U18}	Micron - MT48LC8M16A2	Memory:SDRAM				
			{U19}	Micron - MT48LC8M16A2	Memory:SDRAM				
			{U13}	Micron - MT48LC8M16A2	Memory:SDRAM				
			{U14}	Micron - MT48LC8M16A2	Memory:SDRAM				
20	PEP CP302 SBC	1					4.64E+09	46.40%	(F2) SBC Error in RAM Verification. Error did not disrupt test program.
21	PEP CP302 SBC	1					5.72E+09	57.20%	(F3) 3.3 Volt current spiked from nominal 4.0 A to 5.2 A. Recycled power and current returned to nominal. Reboot OK. REMOVED DSP CARD.
22	PEP CP302 SBC	1					7.60E+09	76.00%	(F2) SBC Error in RAM Verification. Error did not disrupt test program.
23	PEP CP302 SBC	1					1.00E+10	100.00%	No errors.

Run No.	Assembly	Position No.	Component ID	Component No.	Component Description	Vignette	Fluence	Percentage of Full Dose	Results
24	PEP CP302 SBC	2	[U9]	Intel - 82371	PCI-ISA BRIDGE	1 X 1.5	2.22E+09	22.20%	(F1) SBC Error in RAM Verification. Error did not disrupt test program.
			{U15}	Micron - MT48LC8M16A2	Memory:SDRAM				
			{U16}	Micron - MT48LC8M16A2	Memory:SDRAM				
			{U20}	Micron - MT48LC8M16A2	Memory:SDRAM				
			{U21}	Micron - MT48LC8M16A2	Memory:SDRAM				
25	PEP CP302 SBC	2					3.94E+09	39.40%	(F2) SBC Rebooted Automatically. All values normal.
26	PEP CP302 SBC	2					4.72E+09	47.20%	(F1) SBC Error in RAM Verification. Error did not disrupt test program.
27	PEP CP302 SBC	2					4.99E+09	49.90%	(F1) SBC Error in RAM Verification. Error did not disrupt test program.
28	PEP CP302 SBC	2					5.10E+09	51.00%	Errors Caught On the Fly (F1) SBC Error in RAM Verification. Error did not disrupt test program.
							6.27E+09	62.70%	Errors Caught On the Fly (F1) SBC Error in RAM Verification. Error did not disrupt test program.
							8.09E+09	80.90%	Errors Caught On the Fly (F3) SBC Locked Up/Crashed. Recycled power and rebooted OK.

Run No.	Assembly	Position No.	Component ID	Component No.	Component Description	Vignette	Fluence	Percentage of Full Dose	Results
							8.56E+09	85.60%	Errors Caught On the Fly (F1) SBC Error in RAM Verification. Error did not disrupt test program.
29	PEP CP302 SBC	2					1.00E+10	100.00%	No additional errors.
30	PEP CP302 SBC	3	[U10]	Linear Technologies - LT1117	Voltage Regulator	1 X 1.5	1.48E+09	14.80%	(F1) SBC Error in RAM Verification. Error did not disrupt test program.
			{U17}	Micron - MT48LC8M16A2	Memory:SDRAM				
			{U22}	Micron - MT48LC8M16A2	Memory:SDRAM				
			[XT2]	???? - ????	Crystal				
31	PEP CP302 SBC	3					2.32E+09	23.20%	(F2) SBC Locked Up/Crashed. Recycled power and rebooted OK.
32	PEP CP302 SBC	3					4.56E+09	45.60%	(F1) SBC Error in RAM Verification. Error did not disrupt test program.
33	PEP CP302 SBC	3					6.12E+09	61.20%	(F3) SBC Rebooted Automatically. All values normal.
34	PEP CP302 SBC	3					6.63E+09	66.30%	(F2) SBC Locked-Up/Crashed, Address Bus Error. Soft Reboot unsuccessful. Recycled power and rebooted OK.

Run No.	Assembly	Position No.	Component ID	Component No.	Component Description	Vignette	Fluence	Percentage of Full Dose	Results
35	PEP CP302 SBC	3					8.83E+09	88.30%	Errors Caught On the Fly (F1) SBC Error in RAM Verification. Error did not disrupt test program.
							1.00E+10	100.00%	No additional errors.
36	PEP CP302 SBC	4	[U7]	Intel - 82559	Ethernet Controller	1 X 1.5	1.54E+09	15.40%	(F1) SBC Rebooted Automatically. All values normal.
			{U11}	ST Microelectronics - 24C08W6	Memory/SEEprom: Bios ?				
			{U12}	ST Microelectronics - 24C08W6	Memory/SEEprom: Bios ?				
			{U23}	Microchip - 93LC46B	Memory/SEEprom: Bios ?				
			{XT3}	???? - NH25.00/HCJ OK	Clock				
			U37	TI - SN74LVC07A	Hex Buffer/Open Drain				
			{U24}	Linear Technologies - LTC15361	Supply Monitor				
37	PEP CP302 SBC	4					2.45E+09	24.50%	(F1) SBC Rebooted Automatically. All values normal.
38	PEP CP302 SBC	4					2.76E+09	27.60%	(F1) SBC Rebooted Automatically. All values normal.
39	PEP CP302 SBC	4					4.05E+09	40.50%	(F2) SBC Locked Up/Crashed. Recycled power and rebooted OK.
40	PEP CP302 SBC	4					4.60E+09	46.00%	Errors Caught On the Fly (F1) SBC Rebooted Automatically. All values normal. .

Run No.	Assembly	Position No.	Component ID	Component No.	Component Description	Vignette	Fluence	Percentage of Full Dose	Results
							1.00E+10	100.00%	Recorded no additional failures, let total dose run out
41	PEP CP302 SBC	Special Run							Ran this run no beam on card, noted 4 Errors in RAM Verification. Ran additional test with beam off, noted 4 Errors in RAM Verification. Next morning ran twice with beam off, and no Errors in RAM Verification. Ran additional run with beam on, but Faraday Cup in (to look for neutron contribution) with no Errors in RAM Verification.
42	PEP CP302 SBC	5	[U3]	Intel - 82443	Host Bridge/Controller (BX440)/NB	1 X 1 (Actually ran with 1 X 1.5 Vertical)	4.39E+09	43.90%	(F1) SBC Rebooted Automatically. All values normal.
43	PEP CP302 SBC	5					4.96E+09	49.60%	(F2) SBC Error in RAM Verification. Virtual Offset 03B09F23, reads 163, expected 35. Error did not disrupt test program.

Run No.	Assembly	Position No.	Component ID	Component No.	Component Description	Vignette	Fluence	Percentage of Full Dose	Results
44	PEP CP302 SBC	5					5.25E+09	52.50%	(F2) SBC Error in RAM Verification. Virtual Offset 03563245, reads 117, expected 85. Error did not disrupt test program.
45	PEP CP302 SBC	5					5.85E+09	58.50%	(F2) SBC Error in RAM Verification. Virtual Offset 02CBFF81, reads 239, expected 255. Error did not disrupt test program.
46	PEP CP302 SBC	5					6.49E+09	64.90%	Errors Caught On the Fly (F2) SBC Error in RAM Verification. Virtual Offset 03A6FEE, reads 138, expected 170. Error did not disrupt test program.
							7.48E+09	74.80%	Errors Caught On the Fly (F2) SBC Error in RAM Verification. Virtual Offset 04E62DEB, reads 21, expected 85. Error did not disrupt test program.

Run No.	Assembly	Position No.	Component ID	Component No.	Component Description	Vignette	Fluence	Percentage of Full Dose	Results
							8.14E+09	81.40%	Errors Caught On the Fly (F2) SBC Error in RAM Verification. Virtual Offset 02DF1411, reads 16, expected 0. Error did not disrupt test program.
							9.00E+09	90.00%	Errors Caught On the Fly (F2) SBC Error in RAM Verification. Virtual Offset 090D2284, reads 127, expected 255. Error did not disrupt test program.
							9.97E+09	99.70%	Errors Caught On the Fly (F2) SBC Error in RAM Verification. Virtual Offset 0817634A, reads 206, expected 78. Error did not disrupt test program.

Run No.	Assembly	Position No.	Component ID	Component No.	Component Description	Vignette	Fluence	Percentage of Full Dose	Results
47	PEP CP302 SBC	6	[U2]	Standard Microsystems Technology - FDC36C672	Enhanced I/O Controller	1 X 1	8.08E+09	80.80%	(F3) SBC Crashed/Locked-Up. 5.0 Volt current spiked at 2.5 A versus nominal range of 0.7 A to 1.5 A. Attempted to Recycle Power with no communications. 5.0 Volt current constant at 1.7 A after attempted reboots. DESTRUCTIVE EVENT.
			{U29}	Altera - EPM7128STC100-15	CPLD				
48	DY-4 SVME179-1440 SBC and DY-4 Dual Channel 1553B PMC-601	1	{U68}	IDT - QS3257Q	PPC to PCI Bridge Support Logic	1.25 X 1.25	5.50E+09	55.00%	(F1) SBC Rebooted Automatically. All values normal.
			{U69}	IDT - QS3257Q	PPC to PCI Bridge Support Logic				
			{U70}	IDT - QS3257Q	PPC to PCI Bridge Support Logic				
49	DY-4 SVME179-1440 SBC and DY-4 Dual Channel 1553B PMC-601	1					1.24E+10	124.00%	(F2) SBC Crashed/Locked - Up. Soft reboot command effective. Ran past 1.0E+10 to get second data point????

Run No.	Assembly	Position No.	Component ID	Component No.	Component Description	Vignette	Fluence	Percentage of Full Dose	Results
50	DY-4 SVME179-1440 SBC and DY-4 Dual Channel 1553B PMC-601	2	{U71}	IDT - QS3257Q	PPC to PCI Bridge Support Logic	1.25 X 1.25	1.00E+10	100.00%	No errors.
			{U72}	IDT - QS3257Q	PPC to PCI Bridge Support Logic				
			{U73}	IDT - QS3257Q	PPC to PCI Bridge Support Logic				
			{U74}	IDT - QS3257Q	PPC to PCI Bridge Support Logic				
			{U75}	IDT - QS3257Q	PPC to PCI Bridge Support Logic				
51	DY-4 SVME179-1440 SBC and DY-4 Dual Channel 1553B PMC-601	3	{U101}	Phillips - I74F38D	PCI-VME Bridge	1.25 X 1.25	1.00E+10	100.00%	No errors.
			{U102}	Phillips - I74F38D	PCI-VME Bridge Support Logic				
			{U103}	IDT - 74FCT244ATQ	PCI-VME Bridge Support Logic				
			{U104}	IDT - 74FCT245CTQ	VME BUS Buffers I				
			{U118}	Fairchild Semiconductor - NC7SZ126	Ultra High Speed Buffer				
52	DY-4 SVME179-1440 SBC and DY-4 Dual Channel 1553B PMC-601	4	{U117}	Fairchild Semiconductor - NC7SZ126	Ultra High Speed Buffer	1.25 X 1.25	1.00E+10	100.00%	No errors.
			[F1]	Raychem - SMD250-2	Resettable Polyswitch				

Run No.	Assembly	Position No.	Component ID	Component No.	Component Description	Vignette	Fluence	Percentage of Full Dose	Results
53	DY-4 SVME179-1440 SBC and DY-4 Dual Channel 1553B PMC-601	5	[V1]	IRL - BU-61588	1553 Controller	1.25 X 1.25	1.00E+10	100.00%	No errors.
			{U54}	Phillips - 74LVT245PW	64 BIT Flash Data Buffers				
			{U55}	Phillips - 74LVT244APW	PPC to PCI Bridge Support Logic				
			{U56}	Phillips - 74LVT244APW	PPC to PCI Bridge Support Logic				
			{U57}	Phillips - 74LVT244APW	PPC to PCI Bridge Support Logic				
54	DY-4 SVME179-1440 SBC and DY-4 Dual Channel 1553B PMC-601	6	[U27]	AMD - AMD29DL323CB90V1	Bank1 Of Flash Memory	2 X 2.25	1.00E+10	100.00%	No errors. Rebooted at 60% fluence to check flash memory
			[U28]	AMD - AMD29DL323CB90V1	Bank1 Of Flash Memory				
			[U29]	AMD - AMD29DL323CB90V1	Bank1 Of Flash Memory				
			[U31]	AMD - AMD29DL323CB90V1	Bank2 Of Flash Memory				
			[U32]	AMD - AMD29DL323CB90V1	Bank2 Of Flash Memory				
			[U33]	AMD - AMD29DL323CB90V1	Bank2 Of Flash Memory				
			[U35]	AMD - AMD29DL323CB90V1	Bank3 Of Flash Memory				
			[U36]	AMD - AMD29DL323CB90V1	Bank3 Of Flash Memory				
			[U37]	AMD - AMD29DL323CB90V1	Bank3 Of Flash Memory				
			[U44]	Dallas - DS21S07A	SCSI Terminators				
			[U45]	Dallas - DS21S07A	SCSI Terminators				

Run No.	Assembly	Position No.	Component ID	Component No.	Component Description	Vignette	Fluence	Percentage of Full Dose	Results
			[U46]	Dallas - DS21S07A	SCSI Terminators				
			{U98}	IDT - 74FCT245CTQ	VME BUS Buffers I				
			{U99}	IDT - 74FCT245CTQ	VME BUS Buffers I				
			{U100}	IDT - 74FCT245CTQ	VME BUS Buffers I				
			[V5]	IDT - 74FCT373ATQ	De-Muxes				
			[V6]	IDT - 74FCT543ATQ	De-Muxes				
			[V7]	IDT - 74FCT543ATQ	De-Muxes				
			{V14}	IDT - 74FCT373ATQ	De-Muxes				
			{V15}	IDT - 74FCT543ATQ	De-Muxes				
			{V16}	IDT - 74FCT543ATQ	De-Muxes				
			[V8]	IDT - 74FCT244ATQ	RT Address Buffers				
			[V9]	IDT - 74FCT244ATQ	RT Address Buffers				
			{V13}	IDT - 74FCT244ATQ	RT Address Buffers				
			[V11]	IDT - 74FCT244ATQ	RT Address Buffers				
			[V10]	IDT - 74FCT543ATQ	I/O				
			[V12]	IDT - 74FCT543ATQ	I/O				
55	DY-4 SVME179-1440 SBC and DY-4 Dual Channel 1553B PMC-601	7	[U8]			2 X 2.25	5.85E+09	58.50%	(F1) 1553 Test Failure (multiple repeats), soft reboot ineffective, Recycled power and 1553 recovered.
			[U9]	Samsung - K4S280832B-TCIL	DRAM Bank 1				
			[U11]	Samsung - K4S280832B-TCIL	DRAM Bank 1				
			[U12]	Samsung - K4S280832B-TCIL	DRAM Bank 1				
			[U14]	Samsung - K4S280832B-TCIL	DRAM Bank 1				
			[U15]	Samsung - K4S280832B-TCIL	DRAM Bank 1				
			{U83}	Samsung - K4S280832B-TCIL	DRAM Bank 1				

Run No.	Assembly	Position No.	Component ID	Component No.	Component Description	Vignette	Fluence	Percentage of Full Dose	Results
			{U84}	Samsung - K4S280832B-TCIL	DRAM Bank 1				
			{U86}	Samsung - K4S280832B-TCIL	DRAM Bank 1				
			{U87}	Samsung - K4S280832B-TCIL	DRAM Bank 1				
			{U89}	Samsung - K4S280832B-TCIL	DRAM Bank 1				
			{U90}	Samsung - K4S280832B-TCIL	DRAM Bank 1				
			{U79}	Philips - 74LVT245PW	64 BIT Flash Data Buffers				
			{U80}	Philips - 74LVT245PW	64 BIT Flash Data Buffers				
			{U81}	Philips - 74LVT245PW	64 BIT Flash Data Buffers				
			{U82}	Philips - 74LVT245PW	64 BIT Flash Data Buffers				
			[Y1]	???? - ????	RTC Clock				
			[V2]	IDT - 74FCT373ATQ	De-Muxes				
			[V3]	IRL- BU-61588	1553 Controller				
			[VG1]	???? - ????	Clock				
56	DY-4 SVME179-1440 SBC and DY-4 Dual Channel 1553B PMC-601	7					1.50E+10	150.00%	No errors. Ran past 1.0E+10 to get second data point????
57	DY-4 SVME179-1440 SBC and DY-4 Dual Channel 1553B PMC-601	8	{U109}	IDT - 74FCT244ATQ	PCI-VME Bridge	2 X 2.25	1.00E+10	100.00%	No errors.
			[U43]	Tundra - CA91C142B-33IE	PCI TO VME BRIDGE				
			[U47]	Phillips - 174F38D	VME BUS BUFFERS II				

Run No.	Assembly	Position No.	Component ID	Component No.	Component Description	Vignette	Fluence	Percentage of Full Dose	Results
			[U48]	TI - SN74ABT126	VME BUS BUFFERS II				
			[U49]	TI - SN74ABT125	VME BUS BUFFERS II				
			[U50]	TI - SN74ABT126	VME BUS BUFFERS II				
			[U51]	TI - SN74ABT125	P0 CONNECTOR				
			[U52]	Phillips - 174F38D	VME BUS BUFFERS II				
			{U105}	IDT - 74FCT245CTQ	VME BUS BUFFERS I				
			{U106}	IDT - 74FCT245CTQ	VME BUS BUFFERS I				
			{U107}	IDT - 74FCT245CTQ	VME BUS BUFFERS I				
			{U108}	IDT - 74FCT245CTQ	VME BUS BUFFERS I				
			{U110}	IDT - 74FCT245CTQ	VME BUS BUFFERS I				
58	DY-4 SVME179-1440 SBC and DY-4 Dual Channel 1553B PMC-601	9	[G1]	???? - ????	PCI TO SCSI/ETHERNET CONTROLLER	1 X 1.5	7.42E+09	74.20%	(F1) RTC Back-Up Power Test Failure. Error repeated until soft reboot cleared the error.
			{U112}	IC Works Inc. - W48C63-27G	SYSTEM CLOCK GENERATOR				
			[Y2]	???? - ????	DRAM CLOCK				
59	DY-4 SVME179-1440 SBC and DY-4 Dual Channel 1553B PMC-601	9					1.51E+10	151.00%	No errors. Ran past 1.0E+10 to get second data point????

Run No.	Assembly	Position No.	Component ID	Component No.	Component Description	Vignette	Fluence	Percentage of Full Dose	Results
60	DY-4 SVME179-1440 SBC and DY-4 Dual Channel 1553B PMC-601	10	[U10]	Samsung - K4S280832B-TCIL	DRAM Bank 1	1 X 1.5	6.30E+09	63.00%	(F1) Program Exception Error. Soft reboot cleared the error.
			[U13]	Samsung - K4S280832B-TCIL	DRAM Bank 1				
			[U16]	Samsung - K4S280832B-TCIL	DRAM Bank 1				
			{U85}	Samsung - K4S280832B-TCIL	DRAM Bank 1				
			{U88}	Samsung - K4S280832B-TCIL	DRAM Bank 1				
			{U91}	Samsung - K4S280832B-TCIL	DRAM Bank 1				
61	DY-4 SVME179-1440 SBC and DY-4 Dual Channel 1553B PMC-601	10					1.50E+10	150.00%	No errors. Ran past 1.0E+10 to get second data point????
62	DY-4 SVME179-1440 SBC and DY-4 Dual Channel 1553B PMC-601	11	[U1]	Zilog - Z8523016VEC	Enhanced Serial Com. Controller	1 X 1.5	1.00E+10	100.00%	No errors.
			[U2]	Dallas - DS1685QN-5	RTC				
			[U3]	National - DS26C32ATM	Quad Diff Receiver				
			[U4]	Linear Technologies - LTC487IS	Low Power RS485 Driver				
			{U76}	Philips - 74LVT543	CPU Supervisor & NOVRAM				
			{U78}	National - LP2986I	RTC				

Run No.	Assembly	Position No.	Component ID	Component No.	Component Description	Vignette	Fluence	Percentage of Full Dose	Results
63	DY-4 SVME179-1440 SBC and DY-4 Dual Channel 1553B PMC-601	12	[U5]	Maxim - MAX807LEWE	Micro Supervisor	1 X 1.5	9.63E+09	96.30%	(F1) SBC Rebooted Automatically. All values normal.
			[U6]	Symtec - STK14C88-N45I	32KX8 NVSRAM				
			[U7]	Intersil - HIN211EIA	RS232 Receiver				
			{U77}	Exar - ST16C255OIQ48	Duart				
64	DY-4 SVME179-1440 SBC and DY-4 Dual Channel 1553B PMC-601	12					1.01E+10	101.00%	No errors.
65	DY-4 SVME179-1440 SBC and DY-4 Dual Channel 1553B PMC-601	13	{U58}	Phillips - 74LVT244APW	PPC to PCI Bridge Support Logic	1 X 1	4.10E+09	41.00%	(F1) RAM Read/Write Function dumping spaces to the RS 232 Port. Recycled power and could not load boot file. Additional soft reboot command ineffective. Recycled power with a delay (multiple seconds) and restarted file transfer server. Soft reboot command indicated incorrect start-up parameters. Soft reboot with new boot file effective.
66	DY-4 SVME179-1440 SBC and DY-4 Dual Channel 1553B PMC-601	13					1.05E+10	105.00%	No errors.

Run No.	Assembly	Position No.	Component ID	Component No.	Component Description	Vignette	Fluence	Percentage of Full Dose	Results
67	DY-4 SVME179-1440 SBC and DY-4 Dual Channel 1553B PMC-601	14	[G2]	????-????	Ethernet Phyreceiver	1 X 1	1.00E+10	100.00%	No errors.
			[G3]	???? - ????	PCI TO VME BRIDGE				
68	DY-4 SVME179-1440 SBC and DY-4 Dual Channel 1553B PMC-601	15	{U116}	Broadcom - BCM5201KPT	Ethernet Phy Transceiver	1 X 1	2.97E+09	29.70%	No errors, lost beam.
			[U119]	Fairchild Semiconductor - NC7SZ126	Ethernet Phy Transceiver				
69	DY-4 SVME179-1440 SBC and DY-4 Dual Channel 1553B PMC-601	15					4.82E+09	48.20%	(F1) SBC Crashed/Locked-Up, soft reboot effective.
70	DY-4 SVME179-1440 SBC and DY-4 Dual Channel 1553B PMC-601	15					1.00E+10	100.00%	No errors.
71	DY-4 SVME179-1440 SBC and DY-4 Dual Channel 1553B PMC-601	16	{U115}	AMD - D323CB90VI	CPU Supervisor & NOVRAM	1 X 1	1.00E+10	100.00%	No errors. Recycled power at 80% fluence to check flash memory.
			{U53}	Phillips - 74LVT244A	PPC to PCI Bridge Sys Controller				

Run No.	Assembly	Position No.	Component ID	Component No.	Component Description	Vignette	Fluence	Percentage of Full Dose	Results
72	DY-4 SVME179-1440 SBC and DY-4 Dual Channel 1553B PMC-601	17	[U18]	Motorola - MPC750	CPU	1 X 1	7.29E+08	7.29%	(F1) SBC Crashed/Locked-Up. Soft reboot ineffective. Appears to be loading incorrect boot parameters (May be due to flash memory exposure during run 71). Recycled power and reinitialized boot parameters, soft reboot effective.
73	DY-4 SVME179-1440 SBC and DY-4 Dual Channel 1553B PMC-601	17					8.69E+08	8.69%	(F2) Program Execution Interruption, test program continues to run. Consistent Ethernet Ping Failures. Soft reboot effective, proper operations obtained.
74	DY-4 SVME179-1440 SBC and DY-4 Dual Channel 1553B PMC-601	17					1.83E+09	18.30%	(F3) SBC Crashed/Locked-Up. Soft reboot ineffective. Recycled power, reboot effective.
75	DY-4 SVME179-1440 SBC and DY-4 Dual Channel 1553B PMC-601	17					2.61E+09	26.10%	(F3) SBC Crashed/Locked-Up. Soft reboot ineffective. Recycled power, reboot effective.

Run No.	Assembly	Position No.	Component ID	Component No.	Component Description	Vignette	Fluence	Percentage of Full Dose	Results
76	DY-4 SVME179-1440 SBC and DY-4 Dual Channel 1553B PMC-601	17					3.27E+09	32.70%	(F3) SBC Crashed/Locked-Up. Soft reboot ineffective. Recycled power, reboot effective.
77	DY-4 SVME179-1440 SBC and DY-4 Dual Channel 1553B PMC-601	17					3.49E+09	34.90%	Error caught on the fly. (F3) SBC Crashed/Locked-Up. Soft reboot ineffective. Recycled power, reboot effective. Finished 1.0E+10 exposure.
78	DY-4 SVME179-1440 SBC and DY-4 Dual Channel 1553B PMC-601	18	[U39]	Quick Logic - QL3040-1PQ208I	Support Device Interface	1.875 X 1.875	1.00E+10	100.00%	No errors.
			[U30]	AMD - AMD29DL323CB90VI	Bank1 Of Flash Memory				
			[U34]	AMD - AMD29DL323CB90VI	Bank2 Of Flash Memory				
			[U38]	AMD - AMD29DL323CB90VI	Bank3 Of Flash Memory				
			{U93}	Phillips - 74LVT245A	64 BIT Flash Data Buffers				
			{U94}	Phillips - 74LVT245A	64 BIT Flash Data Buffers				
			{U95}	Phillips - 74LVT245A	64 BIT Flash Data Buffers				
			{U96}	Atmel - AT93C66-10SI	4K SEEPROM: Foundation firmware				
			V4	Quick Logic - QL2007-2PQ208I	PCI Bridge				

Run No.	Assembly	Position No.	Component ID	Component No.	Component Description	Vignette	Fluence	Percentage of Full Dose	Results
79	DY-4 SVME179-1440 SBC and DY-4 Dual Channel 1553B PMC-601	19	[U40]	LSI - LSI53C885	PCI SCSI/Ethernet Controller	1.25 X 1.25	1.00E+10	100.00%	No errors.
			{U97}	Atmel - AT34C02	2K SEEPROM: PCI SCSI/Ethernet				
80	DY-4 SVME179-1440 SBC and DY-4 Dual Channel 1553B PMC-601	20	[U19]	GSI Tecknologies - G384036B-166I	L2 Cache Memory - Backside BUS	1.25 X 1.25	4.47E+08	4.47%	(F1) 1553 Test Failure (multiple repeats), soft reboot ineffective, Recycled power and 1553 recovered.
			[U20]	GSI Tecknologies - G384036B-166I	L2 Cache Memory - Backside BUS				
81	DY-4 SVME179-1440 SBC and DY-4 Dual Channel 1553B PMC-601	20					8.16E+08	8.16%	(F2) SBC Crashed/Locked-Up. Recycled power, reboot effective.
82	DY-4 SVME179-1440 SBC and DY-4 Dual Channel 1553B PMC-601	20					1.04E+09	10.40%	(F3) Failed Ping/Program Exception error. Test program continued to run and a second Program Exception error. SBC Crashed/Locked-Up, Recycled power and reboot effective.
83	DY-4 SVME179-1440 SBC and DY-4 Dual Channel 1553B PMC-601	20					1.93E+09	19.30%	(F2) SBC Crashed/Locked-Up. Recycled power, reboot effective.

Run No.	Assembly	Position No.	Component ID	Component No.	Component Description	Vignette	Fluence	Percentage of Full Dose	Results
84	DY-4 SVME179-1440 SBC and DY-4 Dual Channel 1553B PMC-601	20					2.66E+09	26.60%	(F2) SBC Crashed/Locked-Up. System tried to reboot itself, not effective. Recycled power, and indicated an additional transmission error. Current spiked from 2.9 A nominal to 3.2 A. Removed power and terminated this position exposure at 7.44E+09.
85	DY-4 SVME179-1440 SBC and DY-4 Dual Channel 1553B PMC-601	21	[U17]	Galileo - GT-64130-B-1	PPC to PCI Bridge/Sys Controller	1.25 X 1.25	2.56E+09	25.60%	Lost communication on channel 2 of DY-4 card. Test program did not lock-up. Error due to a laptop serial port connection????
86	DY-4 SVME179-1440 SBC and DY-4 Dual Channel 1553B PMC-601	21					7.06E+09	70.60%	(F1) 1553 Test Failure (multiple repeats), soft reboot ineffective, Recycled power and 1553 recovered.
87	DY-4 SVME179-1440 SBC and DY-4 Dual Channel 1553B PMC-601	21					1.00E+10	100.00%	No errors.
88	DY-4 SVME179-1440 SBC and DY-4 Dual Channel 1553B PMC-601	22	[U22]	Maxim - MAX1638EAG	DC/DC Step Down Controller	1.25 X 1.25	1.99E+09	19.90%	(F1) SBC Rebooted Automatically. All values normal.

Run No.	Assembly	Position No.	Component ID	Component No.	Component Description	Vignette	Fluence	Percentage of Full Dose	Results
			[U25]	International Rectifier - IRF7413	Mosfet				
			[U26]	International Rectifier - IRF7413	Mosfet				
			{U92}	Phillips - 74LVT244APW	Octal Buffer/Line Driver				
89	DY-4 SVME179-1440 SBC and DY-4 Dual Channel 1553B PMC-601	22					2.82E+09	28.20%	(F2) SBC Crashed/Locked-Up. Soft reboot not successful. Current spiked from 2.9 A nominal to 3.11 A. Power cycle not effective, can not reboot. 14 hours later (next morning) rebooted with proper operation. Recycled power and verified proper operation. Moved to position 23.
90	DY-4 SVME179-1440 SBC and DY-4 Dual Channel 1553B PMC-601	23	[U21]	Maxim - MAX1638EAG	DC/DC Step Down Controller	1.25 X 1.25	2.38E+09	23.80%	(F1) Program exception error. Soft reboot not effective. Recycled power with effective reboot.
			[U23]	International Rectifier - IRF7413	Mosfet				
			[U24]	International Rectifier - IRF7413	Mosfet				

Run No.	Assembly	Position No.	Component ID	Component No.	Component Description	Vignette	Fluence	Percentage of Full Dose	Results
91	DY-4 SVME179-1440 SBC and DY-4 Dual Channel 1553B PMC-601	23					4.56E+09	45.60%	(F2) 1553 Test Failure / Ethernet Ping Failure, soft reboot ineffective, Recycled power and 1553/Ethernet recovered.
92	DY-4 SVME179-1440 SBC and DY-4 Dual Channel 1553B PMC-601	23					1.00E+10	100.00%	No errors.
93 (BACK TO POSITION 22)	DY-4 SVME179-1440 SBC and DY-4 Dual Channel 1553B PMC-601	22					4.12E+09	41.20%	(F3) Program Exception Error. No auto reboot, but a keystroke produced full recovery.
94	DY-4 SVME179-1440 SBC and DY-4 Dual Channel 1553B PMC-601	22					7.98E+09	79.80%	(F4) Outputting spaces to both serial ports. Apparent current spike @ 3.2 A. Soft reboot ineffective. Power cycle ineffective. Cannot load boot file. Reinitialized boot file, soft reboot effective.
95	DY-4 SVME179-1440 SBC and DY-4 Dual Channel 1553B PMC-601	22					8.86E+09	88.60%	(F5) SBC Crashed/Locked-Up. Soft reboot ineffective. Recycled power with effective reboot.

Run No.	Assembly	Position No.	Component ID	Component No.	Component Description	Vignette	Fluence	Percentage of Full Dose	Results
96	DY-4 SVME179-1440 SBC and DY-4 Dual Channel 1553B PMC-601	22					9.56E+09	95.60%	(F6) Program Exception error. Soft reboot not effective. Recycled power with effective reboot.
97	Bittware DSP Sharc Card	3 (Testing position 3 on spare Bittware DSP Sharc Card, due to original destructive event on position 2 of original test card)	{U9}	Fairchild Semiconductor - NC7SZ08m5	Logic Gate	1 X 1.5	9.10E+08	9.10%	(F1) External Bank 0 Test Error, wrote 0265, reads 0225.
98	Bittware DSP Sharc Card	3					1.11E+09	11.10%	(F2) Current Increase on 3.3 Volt current from nominal 3.8 A to 4.48 A. Recycled power, reboot effective.
99	Bittware DSP Sharc Card	3					1.79E+09	17.90%	(F3) Current Increase on 3.3 Volt current from nominal 3.8 A to 7.9 A. Recycled power and current remained high at 6.2 A. No board function. DESTRUCTIVE EVENT.

Run No.	Assembly	Position No.	Component ID	Component No.	Component Description	Vignette	Fluence	Percentage of Full Dose	Results
100	PEP CP302 SBC	7 (Testing position 7 on spare PEP CP302 SBC Card, due to original destructive event on position 6 of original test card)	[U4]	Chips - M69030	Graphics Accelerator	1 X 1	3.34E+09	33.40%	(F1) SBC error in RAM Verification, Virtual Offset, reads 73, expected 105. Error did not disrupt test program.
101	PEP CP302 SBC	7					4.02E+09	40.20%	(F2) SBC Rebooted Automatically. All values normal. (Potential Bittware file corruption as identified via Check Disc Test)
102	PEP CP302 SBC	7					5.35E+09	53.50%	(F1) SBC error in RAM Verification, reads 245, expected 241. Error did not disrupt test program.
103	PEP CP302 SBC	7					6.50E+09	65.00%	(F1) SBC error in RAM Verification, reads 130, expected 170. Error did not disrupt test program.
104	PEP CP302 SBC	7					8.54E+09	85.40%	(F1) SBC error in RAM Verification, reads 16, expected 0. Error did not disrupt test program.
105	PEP CP302 SBC	7					1.00E+10	100.00%	No errors.

Run No.	Assembly	Position No.	Component ID	Component No.	Component Description	Vignette	Fluence	Percentage of Full Dose	Results
106	PEP CP302 SBC	8	[U1]	Linear Technologies - LT1587CM-1.5	Adjustable Voltage Regulator, 1.5V, 3A	1 X 1	1.25E+09	12.50%	(F1) SBC Crashed/Locked-Up (Black Screen). Soft reboot ineffective. Recycled power with effective reboot.
			{U27}	TI - TPS2015	Mosfet Switch				
			{U28}	TI - TPS2015	Mosfet Switch				
107	PEP CP302 SBC	8					7.22E+09	72.20%	(F1) SBC Crashed/Locked-Up (Zebra Screen). Soft reboot ineffective. Recycled power with effective reboot.
108	PEP CP302 SBC	8					1.00E+10	100.00%	No errors.
109	PEP CP302 SBC	9	{U30}	Maxim - MAX1711EEG	Step Down Controller	1 X 1	1.00E+10	100.00%	No errors.
			{U31}	???? - 4420	Mosfet Driver				
110	PEP CP302 SBC	10	{U32}	???? - 4420	Mosfet Driver	1 X 1	2.22E+09	22.20%	(F1) SBC Crashed/Locked-Up (Black Screen). Soft reboot ineffective. Recycled power with effective reboot.
			{U33}	???? - 4420	Mosfet Driver				
111	PEP CP302 SBC	10					2.50E+09	25.00%	(F1) SBC Crashed/Locked-Up (Blue Screen). Soft reboot ineffective. Recycled power with effective reboot.
112	PEP CP302 SBC	10					6.00E+09	60.00%	(F1) SBC Crashed/Locked-Up (Blue Screen). Soft reboot ineffective. Recycled power with effective reboot.

Run No.	Assembly	Position No.	Component ID	Component No.	Component Description	Vignette	Fluence	Percentage of Full Dose	Results
113	PEP CP302 SBC	10					1.00E+10	100.00%	No errors.
114									IUCF LOST BEAM
115									IUCF LOST BEAM
116	PEP CP302 SBC	11	[U34]	Intel - ????	CPU, Pentium III, 500Mhz, 256k Cache	1.875 X 1.875	5.04E+07	0.50%	(F1) SBC Crashed/Locked-Up (Blue Screen). Soft reboot ineffective. Recycled power with effective reboot.
117	PEP CP302 SBC	11					1.75E+08	1.75%	(F2) SBC Rebooted Automatically. All values normal.
118	PEP CP302 SBC	11					2.99E+08	2.99%	(F2) SBC Rebooted Automatically. All values normal.
119	PEP CP302 SBC	11					4.73E+08	4.73%	(F1) SBC Crashed/Locked-Up. Soft reboot ineffective. Recycled power with effective reboot.
120	PEP CP302 SBC	11					1.90E+09	19.00%	Reboot errors caught on the fly. 2 additional (F2) errors and 1 additional (F1) error occurred prior to 1.90E+09 exposure. Run terminated at this point.
121	PEP CP302 SBC	12	[U35]	Intel - 21554	PCI to PCI Bridge	1.875 X 1.875	2.36E+09	23.60%	(F1) SBC Crashed (Black Screen), Rebooted Automatically.
			{U36}	Maxim - MAX1617MEE	Temperature Sensor				

Run No.	Assembly	Position No.	Component ID	Component No.	Component Description	Vignette	Fluence	Percentage of Full Dose	Results
122	PEP CP302 SBC	12					3.86E+09	38.60%	(F2) SBC Error in RAM Verification. Error did not disrupt test program.
123	PEP CP302 SBC	12					6.35E+09	63.50%	(F2) SBC Error in RAM Verification, reads 2, expected 0. Error did not disrupt test program.
124	PEP CP302 SBC	12					6.95E+09	69.50%	(F3) SBC Crashed/Locked-Up (Black Screen). Soft reboot ineffective. Recycled power with effective reboot.
125	PEP CP302 SBC	12					8.66E+09	86.60%	(F3) SBC Crashed/Locked-Up (Black Screen). Soft reboot ineffective. Recycled power with effective reboot.
126	PEP CP302 SBC	12					1.01E+10	101.00%	No errors.
127	PEP CP302 SBC	13	[U5]	AMD - AM29F002NBT-120EC	Memory: Flash IC, 256k - BIOS	1 X 1.5	4.92E+09	49.20%	3 Power Cycle Reboots all OK to check Disk On Chip (Boot Loader to load VXWORKS). Rebooted with beam off to check Flash BIOS successful.
			[U6]	M-Systems - MD2202-D16	Memory: Flash Disk - 16Mbit - VXWORKS BOOT				
			[U25]	National Semiconductor - LM81BIMIT-3	Micro Monitor				
			{U26}	Motorola - MC74ACT125	Octal Latch				

Run No.	Assembly	Position No.	Component ID	Component No.	Component Description	Vignette	Fluence	Percentage of Full Dose	Results
128	PEP CP302 SBC	13					5.78E+09	57.80%	(F1) SBC Crashed/Locked-Up (Blue Screen). Soft reboot ineffective. Recycled power with effective reboot. (Does not relate to Disk On Chip, no errors on Disk On Chip)
129	PEP CP302 SBC	13					9.95E+09	99.50%	9 Power Cycle Reboots all OK to check Flash Memory for proper Boot Parameters.
130	PEP CP302 SBC	14	{V1}	AD - ADM211ARS	RS232 Transceiver	1 X 1	1.00E+10	100.00%	No errors.
			{V3}	Maxim - MAX3089ESD	RS485/RS422 Transceiver				
131 (Running Position 6, position of original destructive failure on original test board, on spare board)	PEP CP302 SBC	6	[U2]	Standard Microsystems Technology - FDC36C672	Enhanced I/O Controller	1 X 1	1.00E+10	100.00%	No errors. (Original Test Card destructive event in this position)
			{U29}	Altera - EPM7128STC100-15	CPLD				

Run No.	Assembly	Position No.	Component ID	Component No.	Component Description	Vignette	Fluence	Percentage of Full Dose	Results
132	PEP CP302 SBC	6					1.59E+10	159.00%	No errors. SBC Crashed/Locked-Up just prior to beam removal. Recycled power, reboot effective. (Ran an additional 5.9E+09 to try to replicate destructive event on original board)
133 (Running Position 5 on spare board)	PEP CP302 SBC	5	[U3]	Intel - 82443	Host Bridge/Controller (BX440)/NB	1 X 1	1.00E+10	100.00%	No errors. (Multiple errors on this position on Original Test Card)
134 (Running Position 1 on spare board)	PEP CP302 SBC	1	[U8]	Integrated Circuit Systems - ICS9248BF-98	System Clock Generator	1 X 1.5	1.15E+09	11.50%	RAM errors caught on the fly. (F1) SBC Error in RAM Verification. 2 bit error.
			[XT1]	???? - 14a318/HCJ 9L	Clock Gen.				
			{U18}	Micron - MT48LC8M16A2	Memory:SDRAM				
			{U19}	Micron - MT48LC8M16A2	Memory:SDRAM				
			{U13}	Micron - MT48LC8M16A2	Memory:SDRAM				
			{U14}	Micron - MT48LC8M16A2	Memory:SDRAM				
							7.24E+09	72.40%	(F2) SBC Crashed/Locked-Up. Soft reboot ineffective. Recycled power with effective reboot.
135	PEP CP302 SBC	1					8.58E+09	85.80%	(F3) SBC Crashed, Rebooted Automatically.

Run No.	Assembly	Position No.	Component ID	Component No.	Component Description	Vignette	Fluence	Percentage of Full Dose	Results
136	PEP CP302 SBC	1					9.96E+09	99.60%	(F2) SBC Crashed/Locked-Up. Soft reboot ineffective. Recycled power with effective reboot.
137 (Running Position 2 on spare board)	PEP CP302 SBC	2	[U9]	Intel - 82371	PCI-ISA/PCI-ATE/IDE	1 X 1.5	2.32E+09	23.20%	RAM errors caught on the fly. (F1) SBC Error in RAM Verification. 3 bit error.
			{U15}	Micron - MT48LC8M16A2	Memory:SDRAM				
			{U16}	Micron - MT48LC8M16A2	Memory:SDRAM				
			{U20}	Micron - MT48LC8M16A2	Memory:SDRAM				
			{U21}	Micron - MT48LC8M16A2	Memory:SDRAM				
							4.29E+09	42.90%	RAM errors caught on the fly. (F1) SBC Error in RAM Verification. 1 bit error.
							6.69E+09	66.90%	RAM errors caught on the fly. (F1) SBC Error in RAM Verification. 1 bit error.
							9.70E+09	97.00%	RAM errors caught on the fly. (F1) SBC Error in RAM Verification. 2 bit error.
							1.00E+10	100.00%	No errors.

Run No.	Assembly	Position No.	Component ID	Component No.	Component Description	Vignette	Fluence	Percentage of Full Dose	Results
138 (Running Position 3 on spare board)	PEP CP302 SBC	3	[U10]	Linear Technologies - LT1117	Voltage Regulator	1 X 1.5	1.00E+10	100.00%	No errors.
			{U17}	Micron - MT48LC8M16A2	Memory:SDRAM				
			{U22}	Micron - MT48LC8M16A2	Memory:SDRAM				
			[XT2]	???? - ????	Crystal				
139 (Running Position 4 on spare board)	PEP CP302 SBC	4	[U7]	Intel - 82559	Ethernet Controller	1 X 1.5	6.53E+07	0.65%	(F1) SBC Crashed, Rebooted Automatically.
			{U11}	ST Microelectronics - 24C08W6	Memory/SEEprom: Bios ?				
			{U12}	ST Microelectronics - 24C08W6	Memory/SEEprom: Bios ?				
			{U23}	Microchip - 93LC46B	Memory/SEEprom: Bios ?				
			{XT3}	???? - NH25.00/HCJ OK	Clock				
			U37	TI - SN74LVC07A	Hex Buffer/Open Drain				
			{U24}	Linear Technologies - LTC15361	Supply Monitor				
140	PEP CP302 SBC	4					1.73E+09	17.30%	(F1) SBC Crashed, Rebooted Automatically.
141	PEP CP302 SBC	4					2.42E+09	24.19%	RAM errors caught on the fly. (F2) SBC Error in RAM Verification. 1 bit error.

Run No.	Assembly	Position No.	Component ID	Component No.	Component Description	Vignette	Fluence	Percentage of Full Dose	Results
							2.66E+09	26.60%	(F1) SBC Crashed, Rebooted Automatically.
142	PEP CP302 SBC	4					3.10E+09	31.00%	RAM errors caught on the fly. (F2) SBC Error in RAM Verification. 1 bit error.
							6.28E+09	62.80%	(F1) SBC Crashed, Rebooted Automatically.
143	PEP CP302 SBC	4					6.32E+09	63.20%	RAM errors caught on the fly. (F2) SBC Error in RAM Verification. 1 bit error.
							7.52E+09	75.20%	RAM errors caught on the fly. (F2) SBC Error in RAM Verification. 1 bit error.
							8.01E+09	80.10%	(F1) SBC Crashed, Rebooted Automatically.
144	PEP CP302 SBC	4					9.98E+09	99.80%	RAM errors caught on the fly. (F2) SBC Error in RAM Verification. 1 bit error.
							1.00E+10	100.00%	No errors.

Run No.	Assembly	Position No.	Component ID	Component No.	Component Description	Vignette	Fluence	Percentage of Full Dose	Results
145 (Rerunning position 4 with Error Correction Circuitry "enabled")	PEP CP302 SBC	4					1.05E+10	105.00%	(F1) SBC Crashed, Rebooted Automatically.
146	PEP CP302 SBC	4					1.18E+10	118.00%	(F1) SBC Crashed, Rebooted Automatically.
147	PEP CP302 SBC	4					1.22E+10	122.00%	(F1) SBC Crashed, Rebooted Automatically.
148	PEP CP302 SBC	4					1.68E+10	168.00%	(F1) SBC Crashed, Rebooted Automatically.
149 (Rerunning position 2 with Error Correction Circuitry "enabled")	PEP CP302 SBC	2	[U9]	Intel - 82371	PCI-ISA BRIDGE		1.15E+10	114.60%	RAM errors caught on the fly. (F2) SBC Error in RAM Verification. 1 bit error.
			{U15}	Micron - MT48LC8M16A2	Memory:SDRAM				
			{U16}	Micron - MT48LC8M16A2	Memory:SDRAM				
			{U20}	Micron - MT48LC8M16A2	Memory:SDRAM				
			{U21}	Micron - MT48LC8M16A2	Memory:SDRAM				

Run No.	Assembly	Position No.	Component ID	Component No.	Component Description	Vignette	Fluence	Percentage of Full Dose	Results
							1.37E+10	137.00%	RAM errors caught on the fly. (F2) SBC Error in RAM Verification. 1 bit error.
							1.68E+10	168.30%	RAM errors caught on the fly. (F2) SBC Error in RAM Verification. 2 bit error.
							1.95E+10	194.70%	RAM errors caught on the fly. (F2) SBC Error in RAM Verification. 2 bit error.
150 (Rerunning position 11 with Error Correction Circuitry "enabled" and CPU Internal Cache "disabled")	PEP CP302 SBC	11	[U34]	Intel - ????	CPU, Pentium III, 500Mhz, 256k Cache	1.875 X 1.875	1.01E+10	100.80%	(F1) SBC Crashed, Rebooted Automatically. Testing Terminated due to excessive boot time.

APPENDIX C RADIATION TEST RESULTS FOR ELEMENTS OF THE FCF TESTED MARCH 2003 - JSC MODELING SOFTWARE – PRODUCT

IUCF----17March2002----Bittware-DSP-Sharc-Card#1

TEST NUMBER = 000001

PROTON ENERGY = 200.0000 MEV

NOMINAL ENVIRONMENT FILE: ISSONP.DIF

NOMINAL # YEARS ONORBIT: 6.000000

SOLAR FLARE CALCULATION DISABLED

PRODUCT.FOR VERSION 004, UPDATED ON SEPTEMBER 24, 2001

ORBIT AVERAGE DEVICE MTBF(DAYS)

*******PROTON******* *****HEAVY ION****** ********TOTAL*******

RUN ABEN NOMINAL NOMINAL NOMINAL

DEVICE = Pos1F1 # BITS = 1000.000

---

15 26.0 (0.477E+04) (0.107E+04) (0.871E+03)

BST 26.0 0.477E+04 0.107E+04 0.871E+03

DEVICE = Pos1F2 # BITS = 1000.000

---

14 25.9 (0.454E+04) (0.101E+04) (0.829E+03)

BST 25.9 0.454E+04 0.101E+04 0.829E+03

DEVICE = Pos1F3 # BITS = 1000.000

---

13 25.2 (0.303E+04) (0.682E+03) (0.557E+03)

BST 25.2 0.303E+04 0.682E+03 0.557E+03

DEVICE = Pos2F1 # BITS = 1000.000

---

18 22.7 (0.669E+03) (0.155E+03) (0.126E+03)

BST 22.7 0.669E+03 0.155E+03 0.126E+03

DEVICE = Pos2F2 # BITS = 1000.000

---

18 26.9 (0.794E+04) (0.175E+04) (0.144E+04)

BST 26.9 0.794E+04 0.175E+04 0.144E+04

ACCUM BST 0.420E+03 0.960E+02 0.781E+02

NOTE: BST IS BASED ON: SUM ERRORS / SUM FLUENCE

IUCF----17March2002----PEP-CP302-SBC#1

TEST NUMBER = 000001

PROTON ENERGY = 200.0000 MEV

NOMINAL ENVIRONMENT FILE: ISSONP.DIF

NOMINAL # YEARS ONORBIT: 6.000000

SOLAR FLARE CALCULATION DISABLED

PRODUCT.FOR VERSION 004, UPDATED ON SEPTEMBER 24, 2001

ORBIT AVERAGE DEVICE MTBF(DAYS)

*******PROTON******* *****HEAVY ION****** ********TOTAL*******

RUN ABEN NOMINAL NOMINAL NOMINAL

DEVICE = Pos1F1 # BITS = 1000.000

---

19 24.8 (0.245E+04) (0.554E+03) (0.452E+03)

BST 24.8 0.245E+04 0.554E+03 0.452E+03

DEVICE = Pos1F2 # BITS = 1000.000

---

22 25.5 (0.371E+04) (0.832E+03) (0.680E+03)

BST 25.5 0.371E+04 0.832E+03 0.680E+03

DEVICE = Pos1F3 # BITS = 1000.000

---

21 26.2 (0.563E+04) (0.125E+04) (0.102E+04)

BST 26.2 0.563E+04 0.125E+04 0.102E+04

DEVICE = Pos2F1 # BITS = 1000.000

---

28 23.8 (0.137E+04) (0.312E+03) (0.254E+03)

BST 23.8 0.137E+04 0.312E+03 0.254E+03

DEVICE = Pos2F2 # BITS = 1000.000

---

25 25.6 (0.385E+04) (0.863E+03) (0.705E+03)

BST 25.6 0.385E+04 0.863E+03 0.705E+03

DEVICE = Pos2F3 # BITS = 1000.000

---

28 26.9 (0.802E+04) (0.177E+04) (0.145E+04)

BST 26.9 0.802E+04 0.177E+04 0.145E+04

DEVICE = Pos3F1 # BITS = 1000.000

---

35 25.1 (0.286E+04) (0.645E+03) (0.526E+03)

BST 25.1 0.286E+04 0.645E+03 0.526E+03

DEVICE = Pos3F2 # BITS = 1000.000

---

34 25.3 (0.323E+04) (0.726E+03) (0.593E+03)

BST 25.3 0.323E+04 0.726E+03 0.593E+03

DEVICE = Pos3F3 # BITS = 1000.000

---

33 26.4 (0.603E+04) (0.134E+04) (0.110E+04)

BST 26.4 0.603E+04 0.134E+04 0.110E+04

DEVICE = Pos4F1 # BITS = 1000.000

---

40 23.5 (0.110E+04) (0.252E+03) (0.205E+03)

BST 23.5 0.110E+04 0.252E+03 0.205E+03

DEVICE = Pos4F2 # BITS = 1000.000

---

39 25.6 (0.396E+04) (0.887E+03) (0.725E+03)

BST 25.6 0.396E+04 0.887E+03 0.725E+03

DEVICE = Pos5F1 # BITS = 1000.000

---

42 25.8 (0.430E+04) (0.961E+03) (0.786E+03)

BST 25.8 0.430E+04 0.961E+03 0.786E+03

DEVICE = Pos5F2 # BITS = 1000.000

---

46 23.6 (0.119E+04) (0.273E+03) (0.222E+03)

BST 23.6 0.119E+04 0.273E+03 0.222E+03

DEVICE = Pos6F3 # BITS = 1000.000

---

47 26.9 (0.801E+04) (0.177E+04) (0.145E+04)

BST 26.9 0.801E+04 0.177E+04 0.145E+04

ACCUM BST 0.194E+03 0.439E+02 0.358E+02

NOTE: BST IS BASED ON: SUM ERRORS / SUM FLUENCE

IUCF----18March2002----DY4-SVME179&Dual-Channel-1553B

TEST NUMBER = 000001

PROTON ENERGY = 200.0000 MEV

NOMINAL ENVIRONMENT FILE: ISSONP.DIF

NOMINAL # YEARS ONORBIT: 6.000000

SOLAR FLARE CALCULATION DISABLED

PRODUCT.FOR VERSION 004, UPDATED ON SEPTEMBER 24, 2001

ORBIT AVERAGE DEVICE MTBF(DAYS)

*******PROTON******* *****HEAVY ION****** ********TOTAL*******

RUN ABEN NOMINAL NOMINAL NOMINAL

DEVICE = Pos1F1 # BITS = 1000.000

---

48 26.2 (0.541E+04) (0.120E+04) (0.985E+03)

BST 26.2 0.541E+04 0.120E+04 0.985E+03

DEVICE = Pos1F2 # BITS = 1000.000

---

49 27.7 (0.124E+05) (0.272E+04) (0.223E+04)

BST 27.7 0.124E+05 0.272E+04 0.223E+04

DEVICE = Pos7F1 # BITS = 1000.000

---

55 26.3 (0.576E+04) (0.128E+04) (0.105E+04)

BST 26.3 0.576E+04 0.128E+04 0.105E+04

DEVICE = Pos9F1 # BITS = 1000.000

---

58 26.7 (0.734E+04) (0.162E+04) (0.133E+04)

BST 26.7 0.734E+04 0.162E+04 0.133E+04

DEVICE = Pos10F1 # BITS = 1000.000

---

60 26.4 (0.621E+04) (0.138E+04) (0.113E+04)

BST 26.4 0.621E+04 0.138E+04 0.113E+04

DEVICE = Pos12F1 # BITS = 1000.000

---

63 27.2 (0.958E+04) (0.211E+04) (0.173E+04)

BST 27.2 0.958E+04 0.211E+04 0.173E+04

DEVICE = Pos13F1 # BITS = 1000.000

---

65 25.6 (0.401E+04) (0.898E+03) (0.734E+03)

BST 25.6 0.401E+04 0.898E+03 0.734E+03

DEVICE = Pos15F1 # BITS = 1000.000

---

69 25.9 (0.473E+04) (0.106E+04) (0.863E+03)

BST 25.9 0.473E+04 0.106E+04 0.863E+03

DEVICE = Pos17F1 # BITS = 1000.000

---

72 22.7 (0.690E+03) (0.160E+03) (0.130E+03)

BST 22.7 0.690E+03 0.160E+03 0.130E+03

DEVICE = Pos17F2 # BITS = 1000.000

---

73 23.0 (0.826E+03) (0.190E+03) (0.155E+03)

BST 23.0 0.826E+03 0.190E+03 0.155E+03

DEVICE = Pos17F3 # BITS = 1000.000

---

77 23.0 (0.829E+03) (0.191E+03) (0.155E+03)

BST 23.0 0.829E+03 0.191E+03 0.155E+03

DEVICE = Pos20F1 # BITS = 1000.000

---

80 22.0 (0.420E+03) (0.979E+02) (0.794E+02)

BST 22.0 0.420E+03 0.979E+02 0.794E+02

DEVICE = Pos20F2 # BITS = 1000.000

---

84 23.1 (0.843E+03) (0.194E+03) (0.158E+03)

BST 23.1 0.843E+03 0.194E+03 0.158E+03

DEVICE = Pos20F3 # BITS = 1000.000

---

82 23.3 (0.991E+03) (0.228E+03) (0.185E+03)

BST 23.3 0.991E+03 0.228E+03 0.185E+03

DEVICE = Pos21F1 # BITS = 1000.000

---

86 26.6 (0.698E+04) (0.155E+04) (0.127E+04)

BST 26.6 0.698E+04 0.155E+04 0.127E+04

DEVICE = Pos22F1 # BITS = 1000.000

---

88 24.4 (0.192E+04) (0.436E+03) (0.355E+03)

BST 24.4 0.192E+04 0.436E+03 0.355E+03

DEVICE = Pos22F2 # BITS = 1000.000

---

89 25.0 (0.274E+04) (0.618E+03) (0.504E+03)

BST 25.0 0.274E+04 0.618E+03 0.504E+03

DEVICE = Pos22F3 # BITS = 1000.000

---

93 25.7 (0.403E+04) (0.902E+03) (0.737E+03)

BST 25.7 0.403E+04 0.902E+03 0.737E+03

DEVICE = Pos22F4 # BITS = 1000.000

---

94 26.9 (0.791E+04) (0.175E+04) (0.143E+04)

BST 26.9 0.791E+04 0.175E+04 0.143E+04

DEVICE = Pos22F5 # BITS = 1000.000

---

95 27.1 (0.880E+04) (0.194E+04) (0.159E+04)

BST 27.1 0.880E+04 0.194E+04 0.159E+04

DEVICE = Pos22F6 # BITS = 1000.000

---

96 27.2 (0.950E+04) (0.209E+04) (0.172E+04)

BST 27.2 0.950E+04 0.209E+04 0.172E+04

ACCUM BST 0.880E+02 0.202E+02 0.164E+02

NOTE: BST IS BASED ON: SUM ERRORS / SUM FLUENCE

IUCF----19March2002----Bittware-DSP-Sharc-Card#2

TEST NUMBER = 000001

PROTON ENERGY = 200.0000 MEV

NOMINAL ENVIRONMENT FILE: ISSONP.DIF

NOMINAL # YEARS ONORBIT: 6.000000

SOLAR FLARE CALCULATION DISABLED

PRODUCT.FOR VERSION 004, UPDATED ON SEPTEMBER 24, 2001

ORBIT AVERAGE DEVICE MTBF(DAYS)

	*******PROTON*******	*****HEAVY ION******	********TOTAL*******
RUN ABEN	NOMINAL	NOMINAL	NOMINAL
DEVICE = Pos3F1	# BITS =	1000.000	
97 23.1	(0.865E+03)	(0.199E+03)	(0.162E+03)
BST 23.1	0.865E+03	0.199E+03	0.162E+03
DEVICE = Pos3F2	# BITS =	1000.000	
98 23.4	(0.106E+04)	(0.243E+03)	(0.198E+03)
BST 23.4	0.106E+04	0.243E+03	0.198E+03
DEVICE = Pos3F3	# BITS =	1000.000	
99 24.2	(0.172E+04)	(0.392E+03)	(0.319E+03)
BST 24.2	0.172E+04	0.392E+03	0.319E+03

ACCUM BST 0.373E+03 0.856E+02 0.696E+02

NOTE: BST IS BASED ON: SUM ERRORS / SUM FLUENCE

IUCF----20March002----PEP-CP302-SBC#2

TEST NUMBER = 000006

PROTON ENERGY = 200.0000 MEV

NOMINAL ENVIRONMENT FILE: ISSONP.DIF

NOMINAL # YEARS ONORBIT: 6.000000

SOLAR FLARE CALCULATION DISABLED

PRODUCT.FOR VERSION 004, UPDATED ON SEPTEMBER 24, 2001

ORBIT AVERAGE DEVICE MTBF(DAYS)

*******PROTON******* *****HEAVY ION****** ********TOTAL*******

RUN ABEN NOMINAL NOMINAL NOMINAL

DEVICE = Pos1F1 # BITS = 1000.000

---

134 23.5 (0.110E+04) (0.252E+03) (0.205E+03)

BST 23.5 0.110E+04 0.252E+03 0.205E+03

DEVICE = Pos1F2 # BITS = 1000.000

---

136 26.0 (0.489E+04) (0.109E+04) (0.892E+03)

BST 26.0 0.489E+04 0.109E+04 0.892E+03

DEVICE = Pos1F3 # BITS = 1000.000

---

135 27.0 (0.851E+04) (0.188E+04) (0.154E+04)

BST 27.0 0.851E+04 0.188E+04 0.154E+04

DEVICE = Pos2F1 # BITS = 1000.000

---

137 24.7 (0.235E+04) (0.531E+03) (0.433E+03)

BST 24.7 0.235E+04 0.531E+03 0.433E+03

DEVICE = Pos4F1 # BITS = 1000.000

---

148 24.3 (0.180E+04) (0.409E+03) (0.333E+03)

BST 24.3 0.180E+04 0.409E+03 0.333E+03

DEVICE = Pos4F2 # BITS = 1000.000

---

144 24.4 (0.193E+04) (0.437E+03) (0.356E+03)

BST 24.4 0.193E+04 0.437E+03 0.356E+03

DEVICE = Pos7F1 # BITS = 1000.000

---

104 24.5 (0.206E+04) (0.468E+03) (0.381E+03)

BST 24.5 0.206E+04 0.468E+03 0.381E+03

DEVICE = Pos7F2 # BITS = 1000.000

---

101 25.6 (0.393E+04) (0.880E+03) (0.719E+03)

BST 25.6 0.393E+04 0.880E+03 0.719E+03

DEVICE = Pos8F1 # BITS = 1000.000

---

107 25.4 (0.352E+04) (0.791E+03) (0.646E+03)

BST 25.4 0.352E+04 0.791E+03 0.646E+03

DEVICE = Pos10F1 # BITS = 1000.000

---

112 24.4 (0.193E+04) (0.438E+03) (0.357E+03)

BST 24.4 0.193E+04 0.438E+03 0.357E+03

DEVICE = Pos11F1 # BITS = 1000.000

---

119 21.0 (0.219E+03) (0.518E+02) (0.419E+02)

BST 21.0 0.219E+03 0.518E+02 0.419E+02

DEVICE = Pos11F2 # BITS = 1000.000

---

120 22.1 (0.446E+03) (0.104E+03) (0.844E+02)

BST 22.1 0.446E+03 0.104E+03 0.844E+02

DEVICE = Pos12F1 # BITS = 1000.000

---

121 24.7 (0.228E+04) (0.517E+03) (0.421E+03)

BST 24.7 0.228E+04 0.517E+03 0.421E+03

DEVICE = Pos12F2 # BITS = 1000.000

---

123 25.2 (0.309E+04) (0.695E+03) (0.568E+03)

BST 25.2 0.309E+04 0.695E+03 0.568E+03

DEVICE = Pos12F3 # BITS = 1000.000

---

125 25.7 (0.424E+04) (0.948E+03) (0.775E+03)

BST 25.7 0.424E+04 0.948E+03 0.775E+03

DEVICE = Pos13F1 # BITS = 1000.000

---

128 26.3 (0.569E+04) (0.127E+04) (0.104E+04)

BST 26.3 0.569E+04 0.127E+04 0.104E+04

ACCUM BST 0.817E+02 0.189E+02 0.153E+02

NOTE: BST IS BASED ON: SUM ERRORS / SUM FLUENCE

APPENDIX D RESULTS OF PROTON BEAM TESTING OF FCF COMPONENTS PERFORMED IN SEPTEMBER 2003

Run No.	Assembly	Position No.	Component ID	Component No.	Component Description	Vignette	Fluence	Percentage of Full Dose	Results
1	Bittware DSP Sharc Card	7	{U5}	ANALOG DEVICES - ADSP-21160MKB-80	DSP	1.25X1.25	3.13E+07	0.31%	(F1) Current Increase on 3.3 Volt current from nominal 3.6 A to 4.5 A. Recycled power and current remained high at 4.5 A. No board function. DESTRUCTIVE EVENT.

APPENDIX E RADIATION TEST RESULTS FOR ELEMENTS OF THE FCF TESTED SEPTEMBER 2003 - JSC MODELING SOFTWARE – PRODUCT

IUCF----19March2002----Bittware-DSP-Sharc-Card#2

TEST NUMBER = 000001

PROTON ENERGY = 200.0000 MEV

NOMINAL ENVIRONMENT FILE: ISSONP.DIF

NOMINAL # YEARS ONORBIT: 6.000000

SOLAR FLARE CALCULATION DISABLED

PRODUCT.FOR VERSION 004, UPDATED ON SEPTEMBER 24, 2001

ORBIT AVERAGE DEVICE MTBF(DAYS)

	*******PROTON*******	*****HEAVY ION******	********TOTAL*******
RUN ABEN	NOMINAL	NOMINAL	NOMINAL
DEVICE = Pos3F1	# BITS = 1000.000		
97 18.2	(0.280E+02)	(0.685E+01)	(0.551E+01)
BST 18.2	0.280E+02	0.685E+01	0.551E+01
ACCUM BST	0.280E+02	0.685E+01	0.551E+01

NOTE:
BST IS BASED ON: SUM ERRORS / SUM FLUENCE

IUCF----05September2003----Bittware-DSP-Sharc-Card (assuming 4 DSP chips tested, ESTIMATE)

TEST NUMBER = 000002

PROTON ENERGY = 200.0000 MEV

NOMINAL ENVIRONMENT FILE: ISSONP.DIF

NOMINAL # YEARS ONORBIT: 6.000000

SOLAR FLARE CALCULATION DISABLED

PRODUCT.FOR VERSION 004, UPDATED ON SEPTEMBER 24, 2001

ORBIT AVERAGE DEVICE MTBF(DAYS)

	*******PROTON*******	*****HEAVY ION******	********TOTAL*******
RUN ABEN	NOMINAL	NOMINAL	NOMINAL
DEVICE = Pos1F1 # BITS = 1000.000			
2 18.2	(0.280E+02)	(0.685E+01)	(0.551E+01)
BST 18.2	0.280E+02	0.685E+01	0.551E+01
DEVICE = Pos2F1 # BITS = 1000.000			
3 18.2	(0.280E+02)	(0.685E+01)	(0.551E+01)
BST 18.2	0.280E+02	0.685E+01	0.551E+01
DEVICE = Pos3F1 # BITS = 1000.000			
4 18.2	(0.280E+02)	(0.685E+01)	(0.551E+01)
BST 18.2	0.280E+02	0.685E+01	0.551E+01
DEVICE = Pos4F1 # BITS = 1000.000			

5	18.2	(0.280E+02)	(0.685E+01)	(0.551E+01)
BST	18.2	0.280E+02	0.685E+01	0.551E+01
ACCUM	BST	0.701E+01	0.171E+01	0.138E+01

NOTE:
BST IS BASED ON: SUM ERRORS / SUM FLUENCE

APPENDIX F RESULTS OF PROTON BEAM TESTING OF FCF COMPONENTS PERFORMED IN MARCH 2004

Run No.	Assembly	Position No.	Component ID	Component No.	Component Description	Vignette	Fluence	Percentage of Full Dose	Results
1	HS3U Space DSP S/N 1004	1	[U6]	Analog Devices - ADSP-21160MKB-80	DSP # 2	1 X 1	3.9691E+07	0.40%	(F1) Power Trip on DSP # 2, Recover via HH Reopen Command
2	HS3U Space DSP S/N 1004	1					6.9077E+07	0.69%	(F1) Power Trip on DSP # 2, Recover via HH Reopen Command
3	HS3U Space DSP S/N 1004	1					1.2814E+08	1.28%	(F2) Power Trip on DSP # 2, Recover via HH Reopen Command, additional power trip indication via telnet only, HH Reopen again restores full functionality
4	HS3U Space DSP S/N 1004	1					2.0126E+08	2.01%	(F3) Power Trip on DSP # 2, not able to recover with HH Reopen Command, Cycled Power, DESTRUCTIVE EVENT
5	HS3U Space DSP S/N 1002	10	{U28}	Fairchild - IRF7401	FET	1 X 1	3.2335E+09	32.34%	(F2) Power Trip on Unknown DSP, Recover via HH Reopen Command, additional power trip indication via telnet only, HH Reopen again restores full functionality
			{U28}	Fairchild - IRF7401	FET				
			{U29}	Fairchild - IRF7401	FET				
			{U30}	Maxim - MAX5819LEEE	Power Monitor				
6	HS3U Space DSP S/N 1002	10					3.7596E+09	37.60%	No Error. This error previously seen in a non-radiation environment
7	HS3U Space DSP S/N 1002	10					3.8612E+09	38.61%	(F4) Power Trip on Unknown DSP, with off-nominal current draw on 3.3 Volt supply. Cycled power with nominal "idle mode operation". 7x7 convolution presents off-nominal current draws on both supplies. HH Reopen presents nominal operation.
8	HS3U Space DSP S/N 1002	10					4.7543E+09	47.54%	(F3) Power Trip on Unknown DSP, not able to recover with HH Reopen Command, showed power trip on DSP # 2, Cycled Power, DESTRUCTIVE EVENT

Run No.	Assembly	Position No.	Component ID	Component No.	Component Description	Vignette	Fluence	Percentage of Full Dose	Results
9	HS3U Space DSP S/N 1001	9	[U4]	Fairchild - 74LCX540MTC	Octal Buf/Line Driver	1 X 1.5	2.6730E+08	2.67%	(F3) Power Trip on Unknown DSP, attempted immediate power shutdown, not able to recover with HH Reopen Command, showed power trip on DSP # 3, Cycled Power, DESTRUCTIVE EVENT
			[U10]	Not On PCB					
			{U37}	Not On PCB					
			{U38}	Fairchild - IRF7401	FET				
			{U39}	Fairchild - IRF7401	FET				
			{U40}	Maxim - MAX5819LEEE	Power Monitor				
			{U41}	Fairchild - IRF7401	FET				
			{U24}	Fairchild - NC7S08B	Logic Gate				
			{U25}	Fairchild - NC7S08B	Logic Gate				
10	VMIPMC-5790-000 SCSI Controller	1	[U1]	LSI - LSI153C1010-66	SCSI Controller	1 X 1	2.2678E+09	22.68%	(F1) During Read Session, telnet stopped display, SBC screen went blank, Cycled Power, proper operation obtained
11	VMIPMC-5790-000 SCSI Controller	1					3.1254E+09	31.25%	(F2) During Write Session, telnet stopped display, SBC screen went blank, Auto-rebooted with proper operation
12	VMIPMC-5790-000 SCSI Controller	1					5.4302E+09	54.30%	(F3) During Write Session, telnet stopped display, SBC screen went blank, Auto-rebooted with proper operation except an additional error during the first subsequent write session, after that proper operation maintained
13	VMIPMC-5790-000 SCSI Controller	1					5.5679E+09	55.68%	(F4) During Read Session, telnet stopped display, SBC screen went blank, Auto-rebooted with proper operation
14	VMIPMC-5790-000 SCSI Controller	1					5.7197E+09	57.20%	(F5) During Read Session, telnet stopped display, but SBC was maintained, telnet could not reinitialize, Cycled Power, Rebooted SBC with nominal operation
15	VMIPMC-5790-000 SCSI Controller	1					7.8453E+09	78.45%	(F4) During Read Session, telnet stopped display, SBC screen went blank, Auto-rebooted with proper operation

Run No.	Assembly	Position No.	Component ID	Component No.	Component Description	Vignette	Fluence	Percentage of Full Dose	Results
16	VMIPMC-5790-000 SCSI Controller	1					1.0055E+10	100.55%	No errors.
17	VMIPMC-5790-000 SCSI Controller	3	[U15]	AMD - AM29F002NBT-120JC	Memory Flash	1 X 1	1.0026E+10	100.26%	No errors.
18	VMIPMC-5790-000 SCSI Controller	4	[U17]	Lattice - GAL16V8D5LJ	GAL	1 X 1	1.0000E+10	100.00%	No errors.
			[U18]	? - 816B	Logic				
19	VMIPMC-5790-000 SCSI Controller	5	[U16]	Philips - 74F06	Inverter	1 X 1	1.7400E+09	17.40%	(F4) During Read Session, telnet stopped display, SBC screen went blank, Auto-rebooted with proper operation
			[U2]	???? - T02B	Logic				
			[U3]	???? - T02B	Logic				
20	VMIPMC-5790-000 SCSI Controller	5					5.9438E+09	59.44%	(F6) Machine Check Error, SBC did not reboot, did not lose telnet, proper operation after load HH Command
21	VMIPMC-5790-000 SCSI Controller	5					1.0229E+10	102.29%	No errors.
22	VMIPMC-5790-000 SCSI Controller	5							No errors, did not move zone location
23	VMIPMC-5790-000 SCSI Controller	2	[Q1]	Linear Tech - LT1086	Regulator	1 X 1.5	3.2770E+09	32.77%	(F4) During Read Session, telnet stopped display, SBC screen went blank, Auto-rebooted with proper operation
			[U12]	IDT - IDT74FCT377ATQ	Logic Gate				
			[U13]	Atmel - 24C16N	Serial EPROM				
			[U14]	Atmel - 24C16N	Serial EPROM				
24	VMIPMC-5790-000 SCSI Controller	2					3.5315E+09	35.32%	(F7) During Write Session, telnet stopped display, SBC screen went black, Cycled Power with proper operation

Run No.	Assembly	Position No.	Component ID	Component No.	Component Description	Vignette	Fluence	Percentage of Full Dose	Results
25	VMIPMC-5790-000 SCSI Controller	2					7.2149E+09	72.15%	(F8) Machine Check Error indicated by telnet during a Write session, reinitalized disc test and was unsuccessful, Cycled Power, re-initialized with proper operation
26	VMIPMC-5790-000 SCSI Controller	2					9.6844E+09	96.84%	(F8) Machine Check Error indicated by telnet during a Write session, reinitalized disc test and was unsuccessful, Cycled Power, re-initialized with proper operation
27	VMIPMC-5790-000 SCSI Controller	6	[U4]	TI - UCC5630AMWP	SCSI Terminator	2 X 2.25	5.3763E+08	5.38%	(F8) Machine Check Error indicated by telnet during a Write session, reinitalized disc test and was unsuccessful, Cycled Power, re-initialized with proper operation
			[U5]	TI - UCC5630AMWP	SCSI Terminator				
			[U6]	TI - UCC5630AMWP	SCSI Terminator				
			[U7]	TI - UCC5630AMWP	SCSI Terminator				
			[U8]	TI - UCC5630AMWP	SCSI Terminator				
			[U9]	TI - UCC5630AMWP	SCSI Terminator				
			[U10]	TI - ABT374A	Octal Flip Flop				
			[U11]	TI - ABT374A	Octal Flip Flop				
28	VMIPMC-5790-000 SCSI Controller	6					4.5157E+09	45.16%	(F9) Machine Check Error indicated by telnet during a Read Session, re-initialized with proper operation
29	VMIPMC-5790-000 SCSI Controller	6					7.5469E+09	75.47%	(F10) During Read Session, telnet stopped display, SBC screen went blank, auto-rebooted without proper operation, Cycled Power, proper operation not obtained. Swapped out hard drives corrected the problem.
30	VMIPMC-5790-000 SCSI Controller	6					1.0077E+10	100.77%	No errors.
31	HS3U Space DSP S/N 1001	3	{U7}	Quick logic - QL5064-66BPS4846	PCI Controller	1 X 1	3.1434E+08	3.14%	(F5) Auto Shutdown not enabled. Power Trip on DSP # 2, Immediately removed power, Cycled Power with proper operation
			[U2]	Dallas - DS1832U	Micro Monitor IC				
			{U19}	Fairchild - NC7S32B	Logic Gate				

Run No.	Assembly	Position No.	Component ID	Component No.	Component Description	Vignette	Fluence	Percentage of Full Dose	Results
32	HS3U Space DSP S/N 1001	3					1.3447E+09	13.45%	(F6) Single Board Computer rebooted automatically, potential Sharc Fin chip issue, Reinitialize the 7x7 Convolution program.
33	HS3U Space DSP S/N 1001	3					3.0864E+09	30.86%	No error, changed beam current.
34	HS3U Space DSP S/N 1001	3					3.1463E+09	31.46%	(F7) Power Trip on DSP # 3, all on hardware laptop, HH Reopen and reinitialize 7x& Convolution program regained proper operation Check LOG FILE NAMES, MAYBE OFF ONE RUN.
35	HS3U Space DSP S/N 1001	3					5.0327E+09	50.33%	(F8) Machine Interrupt Error reported, Cycled Power, HH Reopen and reinitialize 7x7 Convolution program regained proper operation
36	HS3U Space DSP S/N 1001	3					5.8249E+09	58.25%	(F9) Lost functionality, 3.3 Volt supply at 3.98 versus nominal of 4.20, Cycled Power, reinitialize 7x7 Convolution with proper operation
37	HS3U Space DSP S/N 1001	3					6.1717E+09	61.72%	(F5) Auto Shutdown not enabled. Power Trip on DSP # 2, Immediately removed power, Cycled Power with proper operation
38	HS3U Space DSP S/N 1001	3					7.5852E+09	75.85%	(F6) SBC Rebooted Automatically. All values normal. Stopped this position at this level to proceed to a DSP chip location
39	HS3U Space DSP S/N 1001	7	[U11]	Analog Devices - ADSP-21160MKB-80	DSP # 4	1 X 1.5	6.1285E+06	0.06%	(F1) Power Trip on DSP # 4, all on hardware laptop, HH Reopen gained proper operation
			V1		RAM				
			V2		RAM				
			V5		RAM				
			V6		RAM				
40	HS3U Space DSP S/N 1001	7					5.0492E+07	0.50%	(F3) Power Trip on DSP # 4, not able to recover with HH Reopen Command, Cycled Power, DESTRUCTIVE EVENT
41	HS3U Space DSP S/N	6	[U12]	Analog Devices - ADSP-21160MKB-80	DSP # 1	1 X 1.5	8.1291E+06	0.08%	(F1) Power Trip on DSP # 1, Recover via HH Reopen Command

Run No.	Assembly	Position No.	Component ID	Component No.	Component Description	Vignette	Fluence	Percentage of Full Dose	Results
	1002								
			V3		RAM				
			V4		RAM				
			V7		RAM				
			V8		RAM				
42	HS3U Space DSP S/N 1002	6					8.5425E+07	0.85%	(F1) Power Trip on DSP # 1, Recover via HH Reopen Command
43	HS3U Space DSP S/N 1002	6					1.2355E+08	1.24%	(F1) Power Trip on DSP # 1, Recover via HH Reopen Command
44	HS3U Space DSP S/N 1002	6					1.5320E+08	1.53%	(F3) Power Trip on DSP # 1, not able to recover with HH Reopen Command, Cycled Power, DESTRUCTIVE EVENT
45	LMM Diamond MM32 A/D D/A Converter Card	1 (Whole Card)	N/A	N/A	N/A	No Vignette	1.0604E+08	1.06%	No error, verifying correct output
46	LMM Diamond MM32 A/D D/A Converter Card	1 (Whole Card)					1.0023E+10	100.23%	No errors, Cycled Power @ 6.2E+09 with proper operation.
47	HS3U Space DSP S/N 1004	1	[U6]	Analog Devices - ADSP-21160MKB-80	DSP # 2	1 X 1	1.7744E+07	0.18%	The next 13 runs were all ran with software in the "idle mode" (F1) Power Trip on DSP # 2, Recover via HH Reopen Command
48	HS3U Space DSP S/N 1004	1					5.3312E+07	0.53%	(F1) Power Trip on DSP # 2, Recover via HH Reopen Command
49	HS3U Space DSP S/N 1004	1					5.8767E+07	0.59%	(F1) Power Trip on DSP # 2, Recover via HH Reopen Command
50	HS3U Space DSP S/N 1004	1					6.7202E+07	0.67%	(F1) Power Trip on DSP # 2, Recover via HH Reopen Command
51	HS3U Space DSP S/N 1004	1					9.4176E+07	0.94%	(F1) Power Trip on DSP # 2, Recover via HH Reopen Command

Run No.	Assembly	Position No.	Component ID	Component No.	Component Description	Vignette	Fluence	Percentage of Full Dose	Results
52	HS3U Space DSP S/N 1004	1					1.3436E+08	1.34%	(F1) Power Trip on DSP # 2, Recover via HH Reopen Command
53	HS3U Space DSP S/N 1004	1					1.6911E+08	1.69%	(F1) Power Trip on DSP # 2, Recover via HH Reopen Command
54	HS3U Space DSP S/N 1004	1					2.8797E+08	2.88%	(F1) Power Trip on DSP # 2, Recover via HH Reopen Command
55	HS3U Space DSP S/N 1004	1					3.0599E+08	3.06%	(F1) Power Trip on DSP # 2, Recover via HH Reopen Command
56	HS3U Space DSP S/N 1004	1					3.2209E+08	3.22%	(F1) Power Trip on DSP # 2, Recover via HH Reopen Command
57	HS3U Space DSP S/N 1004	1					3.6724E+08	3.67%	(F1) Power Trip on DSP # 2, Recover via HH Reopen Command
58	HS3U Space DSP S/N 1004	1					3.6724E+08	3.67%	(F1) Power Trip on DSP # 2, Recover via HH Reopen Command
59	HS3U Space DSP S/N 1004	1					3.7749E+08	3.77%	(F1) Power Trip on DSP # 2, Recover via HH Reopen Command
60	HS3U Space DSP S/N 1004	All DSP's (No vignette)					3.4288E+07	0.34%	The next three runs were ran with a 1.5 inch copper block theoretically changing the energy of the protons to 54 meV in 7x7 Convolution mode (F1) Power Trip on DSP # 2, Recover via HH Reopen Command
61	HS3U Space DSP S/N 1004	All DSP's (No vignette)					1.7950E+08	1.80%	(F10) Image Processing Not Completed error, no indication of power trip until after the error prompt, Recover via HH Reopen Command
62	HS3U Space DSP S/N 1004	All DSP's (No vignette)					2.0562E+08	2.06%	(F3) Power Trip on DSP # 1, not able to recover with HH Reopen Command, Cycled Power, DESTRUCTIVE EVENT

Run No.	Assembly	Position No.	Component ID	Component No.	Component Description	Vignette	Fluence	Percentage of Full Dose	Results
63	HS3U Space DSP S/N 1002	2	[U5]	Analog Devices - ADSP-21160MKB-80	DSP # 3	1 X 1	2.7700E+07	0.28%	Next ten runs were run with a software routine called "hhprimes2" which exercises the DSP chips, but not the DMA portion. (F4) Power Trip on Unknown DSP, Cycled power with nominal "idle mode operation". HH Reopen presents nominal operation.
64	HS3U Space DSP S/N 1002	2					6.8342E+07	0.68%	(F4) Power Trip on Unknown DSP, Cycled power with nominal "idle mode operation". HH Reopen presents nominal operation.
65	HS3U Space DSP S/N 1002	2					9.2776E+07	0.93%	(F4) Power Trip on Unknown DSP, Cycled power with nominal "idle mode operation". HH Reopen presents nominal operation.
66	HS3U Space DSP S/N 1002	2					1.0586E+08	1.06%	(F4) Power Trip on Unknown DSP, Cycled power with nominal "idle mode operation". HH Reopen presents nominal operation.
67	HS3U Space DSP S/N 1002	2					1.4156E+08	1.42%	(F4) Power Trip on Unknown DSP, Cycled power with nominal "idle mode operation". HH Reopen presents nominal operation.
68	HS3U Space DSP S/N 1002	2					1.9433E+08	1.94%	(F4) Power Trip on Unknown DSP, Cycled power with nominal "idle mode operation". HH Reopen presents nominal operation.
69	HS3U Space DSP S/N 1002	2					1.9983E+08	2.00%	(F4) Power Trip on Unknown DSP, Cycled power with nominal "idle mode operation". HH Reopen presents nominal operation.
70	HS3U Space DSP S/N 1002	2					2.2500E+08	2.25%	(F4) Power Trip on Unknown DSP, Cycled power with nominal "idle mode operation". HH Reopen presents nominal operation.
71	HS3U Space DSP S/N 1002	2					2.3587E+08	2.36%	(F4) Power Trip on Unknown DSP, Cycled power with nominal "idle mode operation". HH Reopen presents nominal operation.
72	HS3U Space DSP S/N 1002	2					3.1587E+08	3.16%	(F3) Power Trip on DSP # 3, not able to recover with HH Reopen Command, Cycled Power, DESTRUCTIVE EVENT
73	LMM Q-Imaging Camera	1 (Camera Lens Area)	N/A	N/A	N/A	No Vignette	1.0010E+10	100.10%	Image significantly degrades in beam exposure, paused at 5.0E+09 and 8.0E+09 and the image improves during the pauses

Run No.	Assembly	Position No.	Component ID	Component No.	Component Description	Vignette	Fluence	Percentage of Full Dose	Results
74	LMM Q-Imaging Camera	2 (Control Card Area)	N/A	N/A	N/A	No Vignette	1.2274E+09	12.27%	(F1) Lost Image Movement, difficult to obtain exact timing of loss, Cycled power through firewire and regained full functionality
75	LMM Q-Imaging Camera	2 (Control Card Area)					4.2087E+09	42.09%	(F1) Lost Image Movement, difficult to obtain exact timing of loss, Cycled power through firewire and regained full functionality
76	LMM Q-Imaging Camera	2 (Control Card Area)					5.7645E+09	57.65%	(F1) Lost Image Movement, difficult to obtain exact timing of loss, Cycled power through firewire and regained full functionality
77	LMM Q-Imaging Camera	2 (Control Card Area)					6.3578E+09	63.58%	(F1) Lost Image Movement, difficult to obtain exact timing of loss, Cycled power through firewire and regained full functionality
78	LMM Q-Imaging Camera	2 (Control Card Area)					8.6693E+09	86.69%	(F1) Lost Image Movement, difficult to obtain exact timing of loss, Cycled power through firewire and regained full functionality
79	LMM Q-Imaging Camera	2 (Control Card Area)					9.9667E+09	99.67%	(F1) Lost Image Movement, difficult to obtain exact timing of loss, Cycled power through firewire with initial loss of functionality, regained full functionality after approximately 30 minutes.

APPENDIX G RADIATION TEST RESULTS FOR ELEMENTS OF THE FCF TESTED MARCH 2004 - JSC MODELING SOFTWARE – PRODUCT

The MTBF numbers found below are different from the numbers presented in Table III due to the fact that we classified those as only Recoverable and Destructive. This data is broken out for every error type at each location.

IUCF----22March2004----Bittware-DSP-Sharc-Card#1004_DSP # 2

TEST NUMBER = 000001

PROTON ENERGY = 200.0000 MEV

NOMINAL ENVIRONMENT FILE: ISSONP.DIF

NOMINAL # YEARS ONORBIT: 6.000000

SOLAR FLARE CALCULATION DISABLED

PRODUCT.FOR VERSION 004, UPDATED ON SEPTEMBER 24, 2001

ORBIT AVERAGE DEVICE MTBF(DAYS)

*******PROTON******* *****HEAVY ION****** ********TOTAL*******

RUN ABEN NOMINAL NOMINAL NOMINAL

DEVICE = Pos1F1 # BITS = 1000.000

---

2 18.4 (0.310E+02) (0.757E+01) (0.608E+01)

BST 18.4 0.310E+02 0.757E+01 0.608E+01

DEVICE = Pos1F2 # BITS = 1000.000

---

3 20.1 (0.118E+03) (0.280E+02) (0.226E+02)

BST 20.1 0.118E+03 0.280E+02 0.226E+02

DEVICE = Pos1F3 # BITS = 1000.000

---

4 20.8 (0.186E+03) (0.440E+02) (0.356E+02)

BST 20.8 0.186E+03 0.440E+02 0.356E+02

ACCUM BST 0.217E+02 0.525E+01 0.423E+01

NOTE:

BST IS BASED ON: SUM ERRORS / SUM FLUENCE

IUCF----22March2004----Bittware-DSP-Sharc-Card#1002_DSP#2_CIC

TEST NUMBER = 000002

PROTON ENERGY = 200.0000 MEV

NOMINAL ENVIRONMENT FILE: ISSONP.DIF

NOMINAL # YEARS ONORBIT: 6.000000

SOLAR FLARE CALCULATION DISABLED

PRODUCT.FOR VERSION 004, UPDATED ON SEPTEMBER 24, 2001

ORBIT AVERAGE DEVICE MTBF(DAYS)

*******PROTON******* *****HEAVY ION****** ********TOTAL*******

RUN ABEN NOMINAL NOMINAL NOMINAL

DEVICE = Pos10F2 # BITS = 1000.000

---

5 25.2 (0.314E+04) (0.707E+03) (0.577E+03)

BST 25.2 0.314E+04 0.707E+03 0.577E+03

DEVICE = Pos10F4 # BITS = 1000.000

---

7 25.5 (0.377E+04) (0.845E+03) (0.691E+03)

BST 25.5 0.377E+04 0.845E+03 0.691E+03

DEVICE = Pos10F3 # BITS = 1000.000

---

8 25.9 (0.466E+04) (0.104E+04) (0.850E+03)

BST 25.9 0.466E+04 0.104E+04 0.850E+03

ACCUM BST 0.125E+04 0.281E+03 0.230E+03

NOTE:

BST IS BASED ON: SUM ERRORS / SUM FLUENCE

IUCF----22March2004----Bittware-DSP-Sharc-Card#1001_DSP # 4 CIC

TEST NUMBER = 000003

PROTON ENERGY = 200.0000 MEV

NOMINAL ENVIRONMENT FILE: ISSONP.DIF

NOMINAL # YEARS ONORBIT: 6.000000

SOLAR FLARE CALCULATION DISABLED

PRODUCT.FOR VERSION 004, UPDATED ON SEPTEMBER 24, 2001

ORBIT AVERAGE DEVICE MTBF(DAYS)

*******PROTON******* *****HEAVY ION****** ********TOTAL*******

RUN ABEN NOMINAL NOMINAL NOMINAL

DEVICE = Pos9F3 # BITS = 1000.000

---

9 21.2 (0.248E+03) (0.585E+02) (0.473E+02)

BST 21.2 0.248E+03 0.585E+02 0.473E+02

ACCUM BST 0.248E+03 0.585E+02 0.473E+02

NOTE:

BST IS BASED ON: SUM ERRORS / SUM FLUENCE

IUCF----22March2004----Bittware-DSP-Sharc-Card#1001_DSP # 4 / Sharcfin

TEST NUMBER = 000004

PROTON ENERGY = 200.0000 MEV

NOMINAL ENVIRONMENT FILE: ISSONP.DIF

NOMINAL # YEARS ONORBIT: 6.000000

SOLAR FLARE CALCULATION DISABLED

PRODUCT.FOR VERSION 004, UPDATED ON SEPTEMBER 24, 2001

ORBIT AVERAGE DEVICE MTBF(DAYS)

*******PROTON******* *****HEAVY ION****** ********TOTAL*******

RUN ABEN NOMINAL NOMINAL NOMINAL

DEVICE = Pos7F1 # BITS = 1000.000

---

39 16.3 (0.535E+01) (0.134E+01) (0.107E+01)

BST 16.3 0.535E+01 0.134E+01 0.107E+01

DEVICE = Pos3F5 # BITS = 1000.000

---

37 25.1 (0.300E+04) (0.676E+03) (0.551E+03)

BST 25.1 0.300E+04 0.676E+03 0.551E+03

DEVICE = Pos3F6 # BITS = 1000.000

---

38 25.5 (0.371E+04) (0.831E+03) (0.679E+03)

BST 25.5 0.371E+04 0.831E+03 0.679E+03

DEVICE = Pos3F7 # BITS = 1000.000

---

34 25.2 (0.307E+04) (0.690E+03) (0.563E+03)

BST 25.2 0.307E+04 0.690E+03 0.563E+03

DEVICE = Pos3F8 # BITS = 1000.000

---

35 26.0 (0.500E+04) (0.111E+04) (0.911E+03)

BST 26.0 0.500E+04 0.111E+04 0.911E+03

DEVICE = Pos3F9 # BITS = 1000.000

---

36 26.3 (0.573E+04) (0.127E+04) (0.104E+04)

BST 26.3 0.573E+04 0.127E+04 0.104E+04

DEVICE = Pos7F3 # BITS = 1000.000

---

40 18.9 (0.456E+02) (0.111E+02) (0.890E+01)

BST 18.9 0.456E+02 0.111E+02 0.890E+01

ACCUM BST 0.476E+01 0.119E+01 0.951E+00

NOTE:

BST IS BASED ON: SUM ERRORS / SUM FLUENCE

IUCF----22March2004----Bittware-DSP-Sharc-Card#1002_DSP # 1

TEST NUMBER = 000005

PROTON ENERGY = 200.0000 MEV

NOMINAL ENVIRONMENT FILE: ISSONP.DIF

NOMINAL # YEARS ONORBIT: 6.000000

SOLAR FLARE CALCULATION DISABLED

PRODUCT.FOR VERSION 004, UPDATED ON SEPTEMBER 24, 2001

ORBIT AVERAGE DEVICE MTBF(DAYS)

*******PROTON******* *****HEAVY ION****** ********TOTAL*******

RUN ABEN NOMINAL NOMINAL NOMINAL

DEVICE = Pos6F1 # BITS = 1000.000

---

43 18.6 (0.372E+02) (0.905E+01) (0.728E+01)

BST 18.6 0.372E+02 0.905E+01 0.728E+01

DEVICE = Pos6F3 # BITS = 1000.000

---

44 20.4 (0.141E+03) (0.335E+02) (0.271E+02)

BST 20.4 0.141E+03 0.335E+02 0.271E+02

ACCUM BST 0.294E+02 0.713E+01 0.574E+01

NOTE:

BST IS BASED ON: SUM ERRORS / SUM FLUENCE

IUCF----22March2004----Bittware-DSP-Sharc-Card#1004_DSP_IdleMode

TEST NUMBER = 000006

PROTON ENERGY = 200.0000 MEV

NOMINAL ENVIRONMENT FILE: ISSONP.DIF

NOMINAL # YEARS ONORBIT: 6.000000

SOLAR FLARE CALCULATION DISABLED

PRODUCT.FOR VERSION 004, UPDATED ON SEPTEMBER 24, 2001

ORBIT AVERAGE DEVICE MTBF(DAYS)

*******PROTON******* *****HEAVY ION****** ********TOTAL*******

RUN ABEN NOMINAL NOMINAL NOMINAL

DEVICE = Pos1F1 # BITS = 1000.000

---

59 18.1 (0.260E+02) (0.635E+01) (0.510E+01)

BST 18.1 0.260E+02 0.635E+01 0.510E+01

ACCUM BST 0.260E+02 0.635E+01 0.510E+01

NOTE:

BST IS BASED ON: SUM ERRORS / SUM FLUENCE

IUCF----22March2004----Bittware-DSP-Sharc-Card#1002_DSP#3_Primes Mode

TEST NUMBER = 000007

PROTON ENERGY = 200.0000 MEV

NOMINAL ENVIRONMENT FILE: ISSONP.DIF

NOMINAL # YEARS ONORBIT: 6.000000

SOLAR FLARE CALCULATION DISABLED

PRODUCT.FOR VERSION 004, UPDATED ON SEPTEMBER 24, 2001

ORBIT AVERAGE DEVICE MTBF(DAYS)

*******PROTON******* *****HEAVY ION****** ********TOTAL*******

RUN ABEN NOMINAL NOMINAL NOMINAL

DEVICE = Pos2F3 # BITS = 1000.000

---

71 18.0 (0.234E+02) (0.574E+01) (0.461E+01)

72 21.4 (0.295E+03) (0.692E+02) (0.560E+02)

BST 19.0 0.500E+02 0.121E+02 0.973E+01

ACCUM BST 0.500E+02 0.121E+02 0.973E+01

NOTE:

BST IS BASED ON: SUM ERRORS / SUM FLUENCE

IUCF----23March2004----VMIPMC-5790-000

TEST NUMBER = 000008

PROTON ENERGY = 200.0000 MEV

NOMINAL ENVIRONMENT FILE: ISSONP.DIF

NOMINAL # YEARS ONORBIT: 6.000000

SOLAR FLARE CALCULATION DISABLED

PRODUCT.FOR VERSION 004, UPDATED ON SEPTEMBER 24, 2001

ORBIT AVERAGE DEVICE MTBF(DAYS)

*******PROTON******* *****HEAVY ION****** ********TOTAL*******

RUN ABEN NOMINAL NOMINAL NOMINAL

DEVICE = Pos1F1 # BITS = 1000.000

---

10 24.6 (0.220E+04) (0.497E+03) (0.405E+03)

BST 24.6 0.220E+04 0.497E+03 0.405E+03

DEVICE = Pos1F2 # BITS = 1000.000

---

11 25.2 (0.305E+04) (0.685E+03) (0.560E+03)

BST 25.2 0.305E+04 0.685E+03 0.560E+03

DEVICE = Pos1F3 # BITS = 1000.000

---

12 26.2 (0.534E+04) (0.119E+04) (0.973E+03)

BST 26.2 0.534E+04 0.119E+04 0.973E+03

DEVICE = Pos1F5 # BITS = 1000.000

---

14 26.2 (0.563E+04) (0.125E+04) (0.102E+04)

BST 26.2 0.563E+04 0.125E+04 0.102E+04

DEVICE = Pos1F4 # BITS = 1000.000

---

15 25.6 (0.384E+04) (0.860E+03) (0.702E+03)

BST 25.6 0.384E+04 0.860E+03 0.702E+03

DEVICE = Pos5F4 # BITS = 1000.000

---

19 24.2 (0.167E+04) (0.381E+03) (0.310E+03)

BST 24.2 0.167E+04 0.381E+03 0.310E+03

DEVICE = Pos5F6 # BITS = 1000.000

---

20 26.3 (0.585E+04) (0.130E+04) (0.106E+04)

BST 26.3 0.585E+04 0.130E+04 0.106E+04

DEVICE = Pos2F4 # BITS = 1000.000

---

23 25.3 (0.319E+04) (0.718E+03) (0.586E+03)

BST 25.3 0.319E+04 0.718E+03 0.586E+03

DEVICE = Pos2F7 # BITS = 1000.000

---

24 25.4 (0.344E+04) (0.773E+03) (0.631E+03)

BST 25.4 0.344E+04 0.773E+03 0.631E+03

DEVICE = Pos2F8 # BITS = 1000.000

---

26 25.9 (0.475E+04) (0.106E+04) (0.867E+03)

BST 25.9 0.475E+04 0.106E+04 0.867E+03

DEVICE = Pos6F8 # BITS = 1000.000

---

27 22.3 (0.507E+03) (0.118E+03) (0.956E+02)

BST 22.3 0.507E+03 0.118E+03 0.956E+02

DEVICE = Pos6F9 # BITS = 1000.000

---

28 25.8 (0.443E+04) (0.990E+03) (0.809E+03)

BST 25.8 0.443E+04 0.990E+03 0.809E+03

DEVICE = Pos6F10 # BITS = 1000.000

---

29 26.8 (0.747E+04) (0.165E+04) (0.135E+04)

BST 26.8 0.747E+04 0.165E+04 0.135E+04

ACCUM BST 0.188E+03 0.427E+02 0.348E+02

NOTE:

BST IS BASED ON: SUM ERRORS / SUM FLUENCE